Flash D

Electrec Energy Analyzer

User Manual

Version 8 November 2005
The document can be modified without prior information.

Index

INTRODUCTION

We thank you for choosing an Electrex instrument
We invite you to carefully read this instructions manual for the best use of the **Flash D** instruments.

1.1 COPYRIGHT

1.2 WARRANTY

This product is covered by a warranty against material and manufacturing defects for a period of 36 months period from the manufacturing date
The warranty does not cover the defects that are due to:
• Negligent and improper use
• Failures caused by atmospheric hazards
• Acts of vandalism
• Wear out of materials
Electrex reserves the right, at its discretion, to repair or substitute the faulty products
The warranty is not applicable to the products that will result defective in consequence of a negligent and improper use or an operating procedure not contemplated in this manual.

1.3 RETURN AND REPAIR FORMALITIES

Electrex accepts the return of instruments for repair **only** when authorized in advance. For instrument purchased directly, the repair authorization must be requested to Electrex directly by using the enclosed RMA form. We recommend otherwise to contact your local distributor for assistance on the return/repair formalities. In both the cases, the following information must be supplied:

- Company full data
- Contact name for further communication
- Product description
- Serial number
- Description of the returned accessories
- Invoice / Shipping document number and date
- Detailed description of the fault and of the operating condition when the fault occurred

The Electrex repair lab will send the authorization number to the customer directly or to the distributor as per applicable case. The RMA authorization number shall be clearly marked on the packaging and on the return transport document.
WARNING: *Failure to indicate the RMA number on the external packaging will entitle our warehouse to refuse the delivery upon arrival and to return the parcel at sender's charge.*

The material must be shipped:
- within 15 working days from the receipt of the return authorization number
- free destination i.e. all transport expenses at sender's charge.
- to the following address: **Electrex S.r.l.**
  Via Claudia 96 - 41056 Savignano s/P (MO) - Italy
  Atn. Repair laboratory
- the units covered by warranty must be returned in their **original packaging**.

1.3.1 RE-SHIPPING OF REPAIRED PRODUCT

The terms for re-shipment of repaired products are ex-works, i.e. the transport costs are at customer charge.
Products returned as detective but found to be perfectly working by our laboratories, will be charged a fixed fee (40.00 Euro + VAT where applicable) to account for checking and testing time irrespective of the warranty terms.

1.3.2 Return Material Authorization (RMA form)

Request for the authorization number for the return of goods

Date:
Company:
Contact name:
TEL: FAX:
Product description:
Serial number:
Description of the returned accessories (if any):
Original purchase Invoice (or Shipping document) number and date. NB: The proof of purchase must be provided by the customer. Failure to complete this area will automatically void all warranty.
Detailed description of the malfunction and of the operating conditions when the fault occurred
☐ Tick off for a quotation
Should a product be found by our laboratories to be perfectly working, a fixed amount of **40 Euro** (+VAT if applicable) will be charged to account for checking and testing time irrespective of the warranty tems.

Space reserved to ELECTREX

R.M.A. No.

The RMA number shall be clearly indicated on the external packaging and on the shipping document:. Failure to observe this requirement will entitle the ELECTREX warehouse to refuse the delivery.

2 Safety

This instrument was manufactured and tested in compliance with IEC 61010 class 2 standards for operating voltages up to 250 VAC rms phase to neutral.
In order to maintain this condition and to ensure safe operation, the user must comply with the indications and markings contained in the following instructions:

- When the instrument is received, before starting its installation, check that it is intact and no damage occurred during transport.
- Before mounting, ensure that the instrument operating voltages and the mains voltage are compatible then proceed with the installation.
- The instrument power supply needs no earth connection.
- The instrument is not equipped with a power supply fuse; a suitable external protection fuse must be foreseen by the contractor.
- Maintenance and/or repair must be carried out only by qualified, authorized personnel
- If there is ever the suspicion that safe operation is no longer possible, the instrument must be taken out of service and precautions taken against its accidental use.
- Operation is no longer safe when:
  1) There is clearly visible damage.
  2) The instrument no longer functions.
  3) After lengthy storage in unfavorable conditions.
  4) After serious damage occurred during transport

The instruments FLASH D must be installed in respect of all the local regulations.

2.1 Operator safety

Warning: Failure to observe the following instructions may lead to a serious danger of death.

- During normal operation dangerous voltages can occur on instrument terminals and on voltage and current transformers. Energized voltage and current transformers may generate lethal voltages. Follow carefully the standard safety precautions while carrying out any installation or service operation.
- The terminals of the instrument **must** not be accessible by the user after the installation. The user should only be allowed to access the instrument front panel where the display is located.
- Do not use the digital outputs for protection functions nor for power limitation functions. The instrument is suitable only for secondary protection functions.
- The instrument must be protected by a breaking device capable of interrupting both the power supply and the measurement terminals. It must be easily reachable by the operator and well identified as instrument cut-off device.
- The instrument and its connections must be carefully protected against short-circuit.

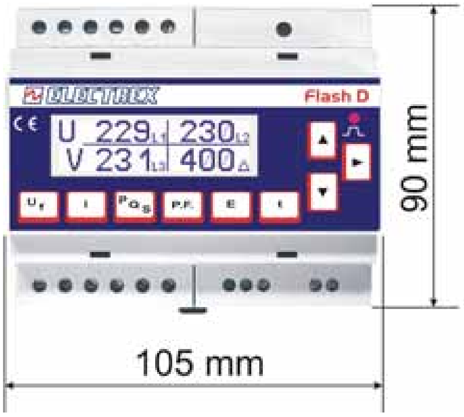
Precautions: Failure to respect the following instructions may irreversibly damage to the instrument.

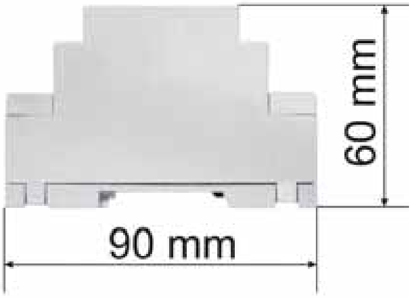
- The instrument is equipped with PTC current limiting device but a suitable external protection fuse should be foreseen by the contractor.
- The outputs and the options operate at low voltage level; they cannot be powered by any unspecified external voltage.
- The application of currents not compatible with the current inputs levels will damage to the instrument.

3 Mounting

3.1 Instruments size (mm)

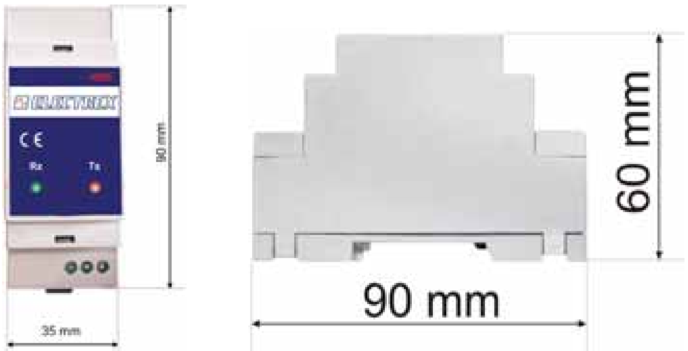
6 DIN rail modules





3.2 Optional modules size (mm)

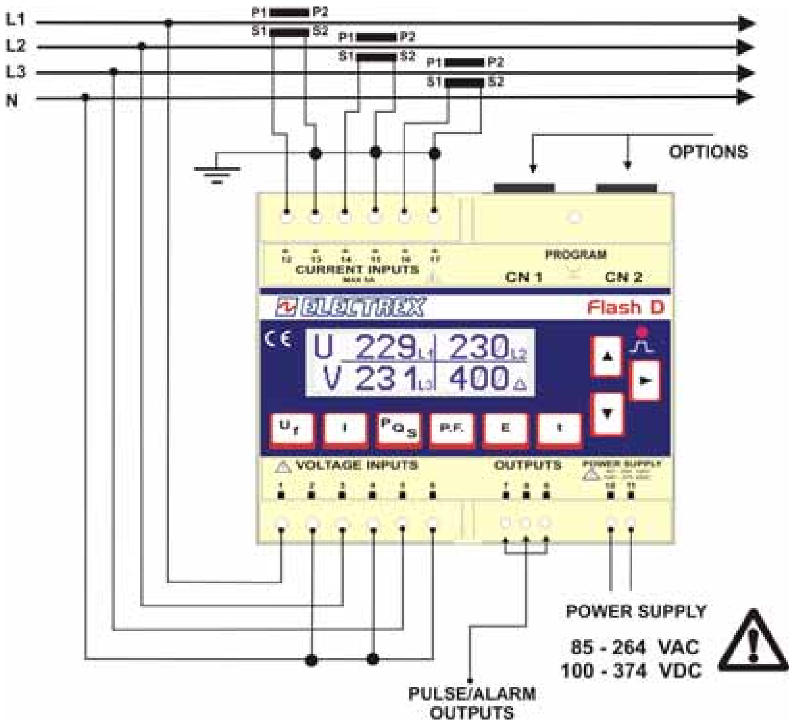
2 DIN rail modules.



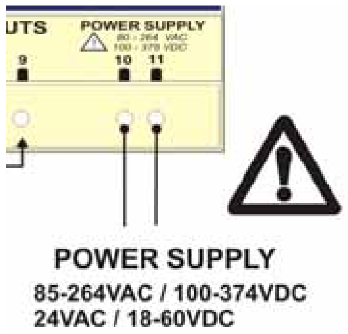
3.3 Fixing and blocking

The instrument (as well as the optional modules) are fixed to the DIN rail by means of the spring clip located on the rear side of the unit.

4 Wiring diagrams



4.1 Power supply



The instrument is fitted with a separate power supply with extended operating range. The power supply terminals are numbered (10) and (11). Use cables with max cross-section of 4 mm^2.

4.2 Measurement connections

4.2.1 Voltage connection

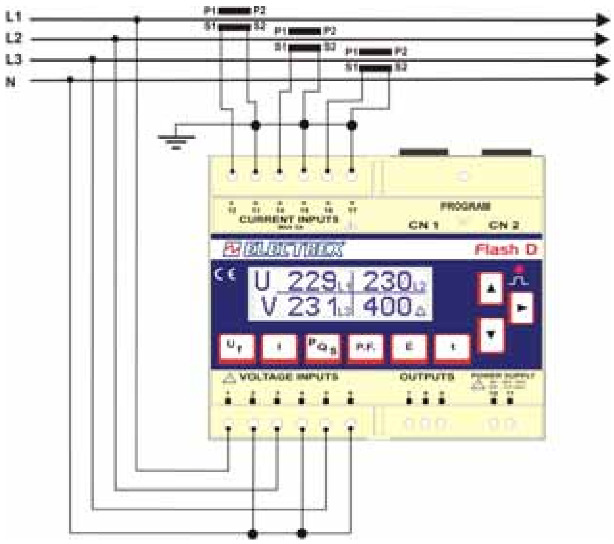
Use cables with max cross-section of 4 mm^2 and connect them to the terminals marked VOLTAGE INPUT on the instrument according to the applicable diagrams that follow.

4.2.2 Current connection

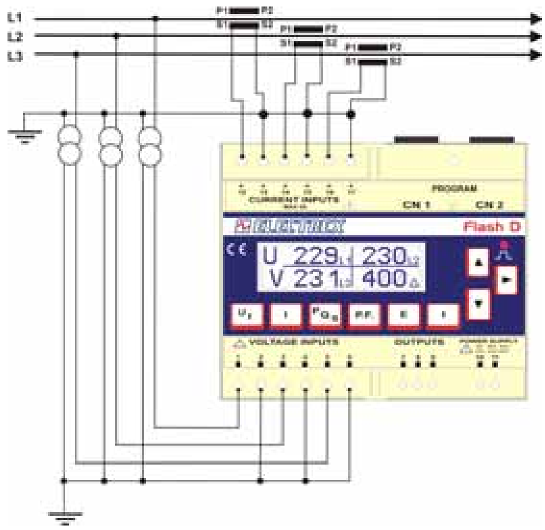
It is necessary to use external CTs with a primary rating adequate to the load to be metered and with a 5A secondary rating. The number of CTs to be used (1, 2 or 3) depends upon the type of network.
Connect the CT output(s) to the terminals marked CURRENT INPUT of the instrument according to the applicable diagrams that follow.
Use cables with cross-section adequate to the VA rating of the CT and to the distance to be covered. The max cross-section for the terminals is 4 mm^2.
N.B. The CT secondary must always be in short circuit when not connected to the instrument in order to avoid damages and risks for the operator.

Warning: THE PHASE RELATIONSHIP AMONG VOLTAGE AND CURRENT SIGNALS MUST BE CAREFULLY RESPECTED. ALL DISREGARD OF THIS RULE OR OF THE WIRING DIAGRAM LEADS TO SEVERE MEASUREMENT ERRORS.

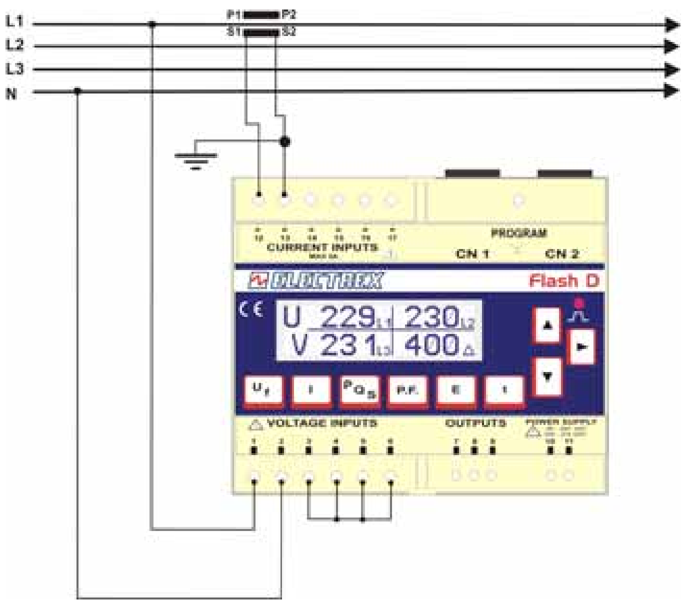
4.2.3 4W Star connection (4 wire)



Low voltage 3 CTs
Configuration 3Ph/4W



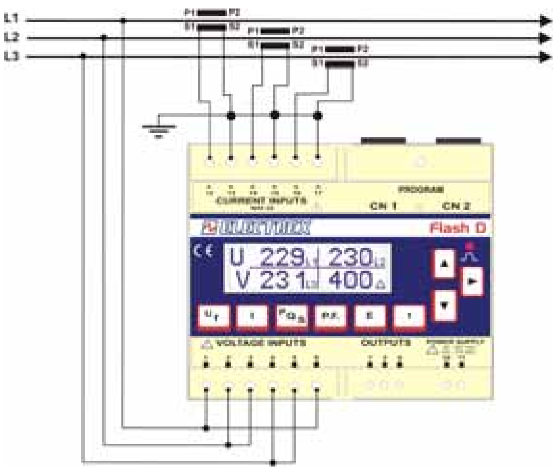
High voltage 3 PTs 3 CTs
Configuration 3Ph/4W



Low Voltage 1 CT (symmetrical and balanced load)
Configuration 3Ph/4W-Bal

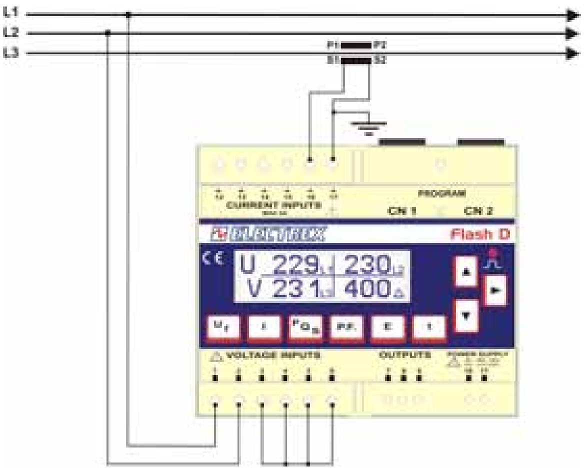
4.2.4 3W Delta connection (3 wire)

Connection with 3 CTs



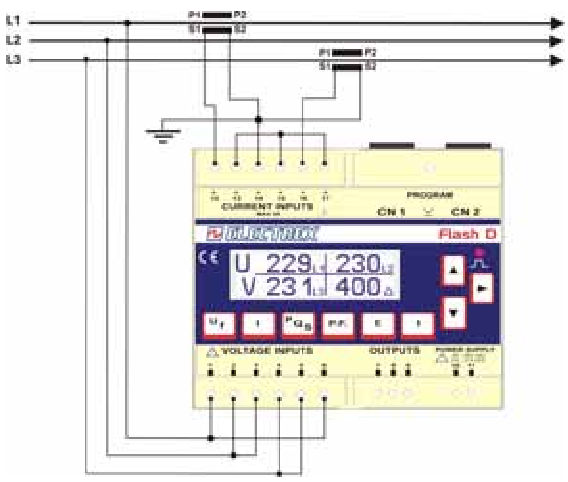
Low Voltage 3 CTs (unbalanced load)
Configuration 3Ph/3W

Connection with 1 CT

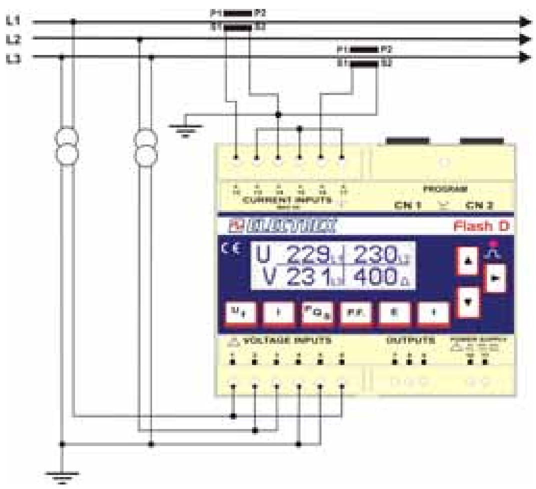


Low Voltage 1 CT (symmetrical and balanced load)
Configuration 3Ph/3W-Bal

4.2.4.1 Connection with 2 CTs on L1 and L3

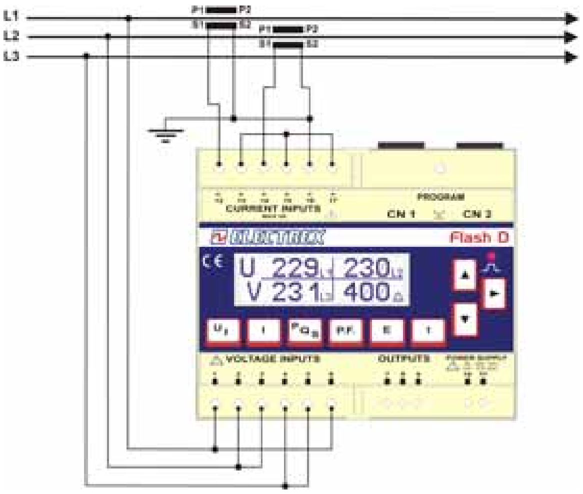


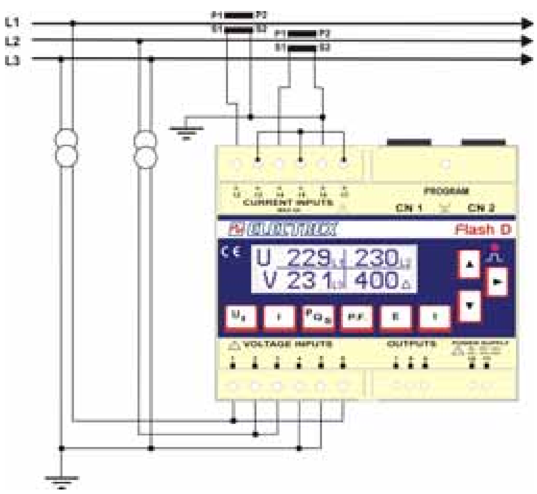
Low Voltage 2 CTs
Configuration 3Ph/3W



High Voltage 2 PTs 2 CTs
Configuration 3Ph/3W

4.2.4.2 Connection with 2 CTs on L1 and L2

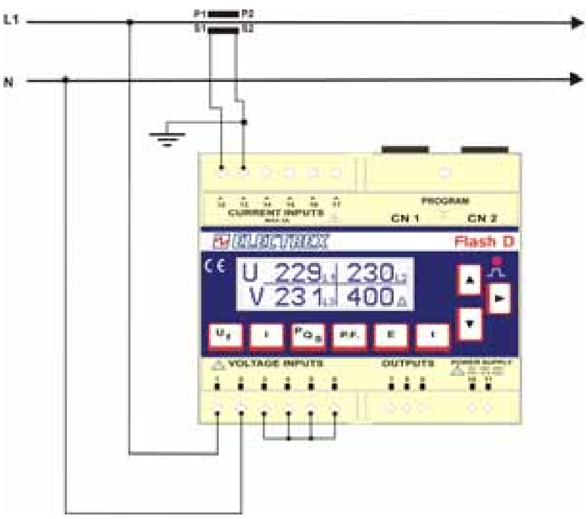




Low Voltage 2 CTs
Configuration 3Ph/3W

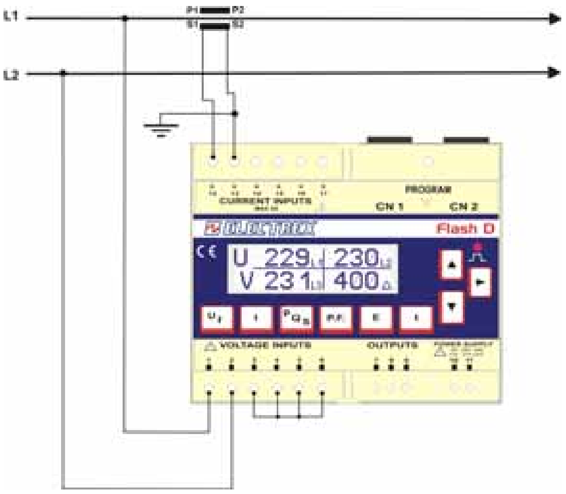
High Voltage 2 PTs 2 CTs
Configuration 3Ph/3W

4.2.5 2 Wire connection (single phase)



Low Voltage (phase-neutral) 1 CT
Configuration 1Ph/2W

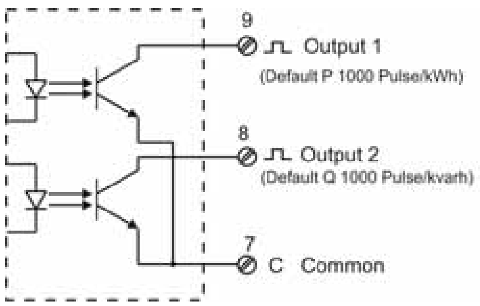
4.2.6 2 Wire connection (bi-phase)

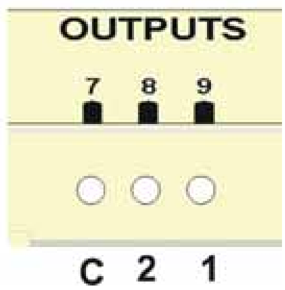


Low Voltage (phase-phase) 1 CT
Configuration **2Ph/2W**

4.3 Outputs connection

The instrument is equipped with two opto-isolated transistor outputs rated 27 Vdc, 27 mA (DIN 43864 standards).
The outputs working mode is set by default to operate as pulse output proportional to the Active energy (output 1) and to the Reactive energy (output 2). They support an output rate of 1.000 pulses per kWh (or kvarh) referred to the instrument input range without any CT and PT multiplier.





In order to calculate the energy value of each pulse the following formula must be considered.

$$K_P = \frac{K_{CT} \times K_{PT}}{Pulse / kWh}$$

Where: K_p = energy of each pulse; K_{CT} = CT ratio ; K_{PT} = PT ratio ;
Pulse/kWh = Pulse rate

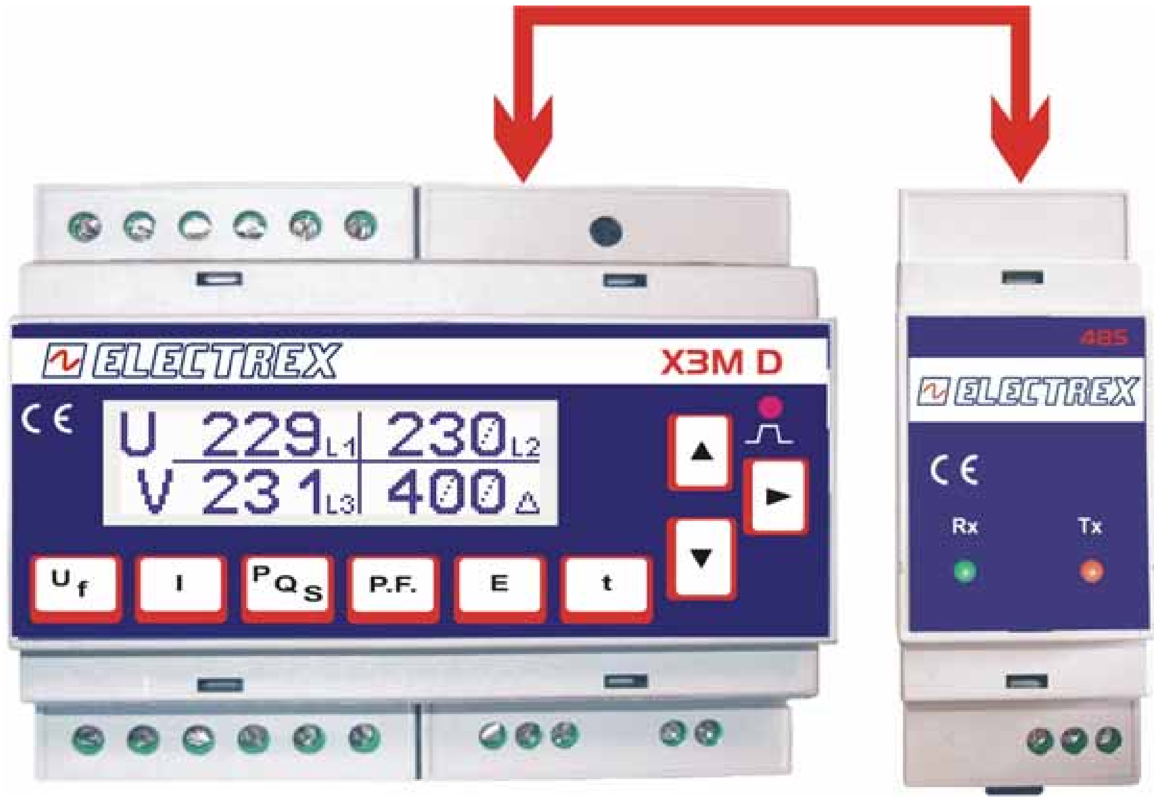
Example: CT = 100/5; PT = 20.000/100 $K_P = \frac{20 \times 200}{1000} = 4 kWh / pulse$ or **kWh** = Pulse count/4

Other pulse rate settings may be however programmed as described in the instrument set up section.
The operating mode of the digital outputs may also be changed to work as alarm output or as remote output device controlled by the Modbus protocol as described in the instrument set up section.

4.4 Optional modules connection

The optional modules shall be placed beside of the instrument and shall be connected to the same by means of the cable supplied with.

The optional modules are self-supplied; the instrument recognises the type of option(s) connected and the applicable programming menu will automatically appear when necessary.



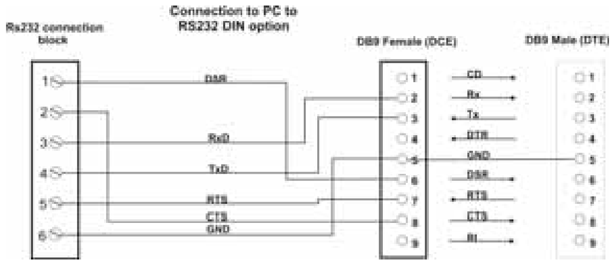
CN1 connector: suitable for the RS485 or RS232 optional modules
CN2 connector: suitable for the 4-20 mA optional module or for the Hardware up-date key

4.4.1 RS485 Option

RS485 pin out	
1	**A +**
2	**B -**
3	**Shield**

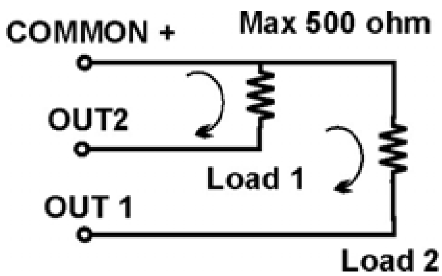
4.4.2 RS232 Option

RS232 pin out	
1	DSR (Handshake to DTE)
2	CTS (Handshake to DTE)
3	RD (Data to DTE)
4	TD (Data from DTE)
5	RTS (Handshake from DTE)
6	GND



4.4.3 Dual 4-20 mA analog output option

4-20 mA pin out	
1	CH1 Channel 1
2	CH2 Channel 2
3	Source Common +



NB. The outputs are self powered; do not use external power supply.

5 Instrument use

5.1 Instrument set up

The set up procedure allows to program the instrument operating parameters.
Entry in the programming procedure is obtained by pressing the PROGRAM button that is located on the upper right side of the instrument.

Program button

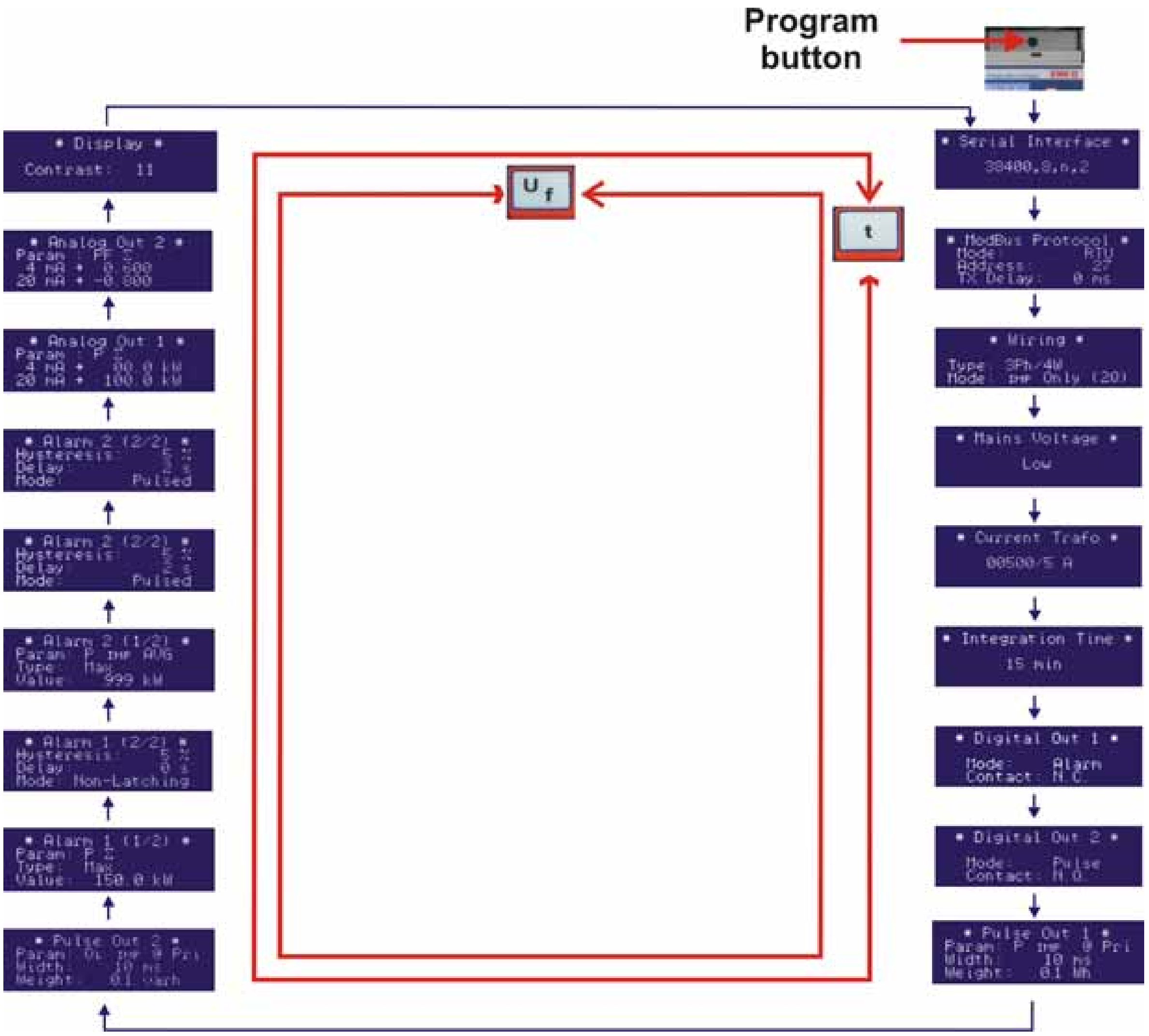
The ▶ key allows to scroll the various entry fields within a set up page as well as to pass to the next page upon scrolling all the fields of one page.

The ▼ and ▲ keys allow the modification of the flashing field being currently selected.
The content of a field can be either numeric or a parameter controlling the device behavior.

The t key advances to the next page, the U f key returns to the previous page

By pressing the PROGRAM button (while in any configuration page) the menu is exited and the configuration entries so far performed are saved.

5.1.1 Set up sequence



Within the first page of the instrument set up menu, the following functions are available too.

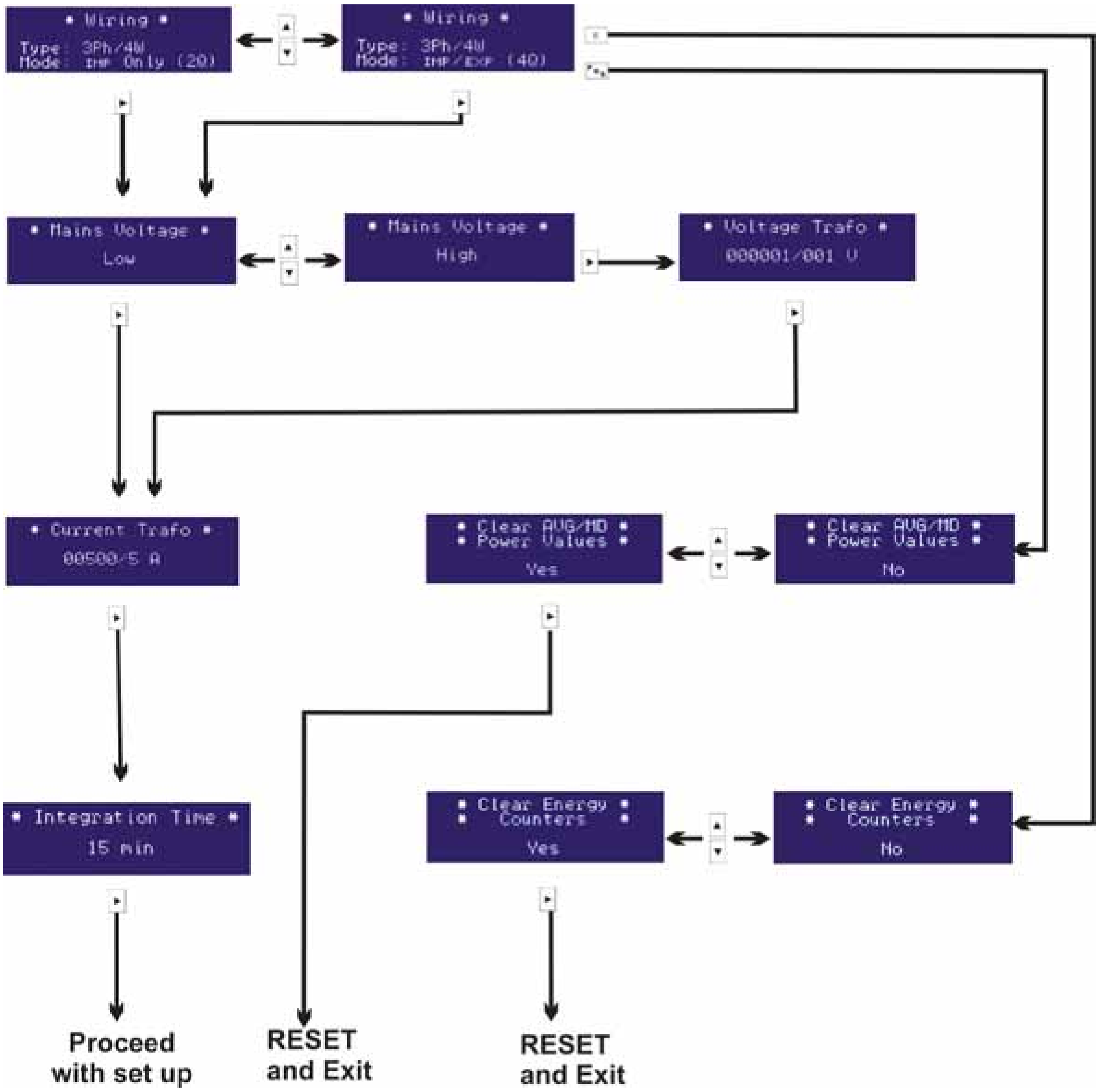
- a pressure of the  key opens the energy counters reset page.

- a pressure of the  key opens the reset page of the average and maximum demand.

Here below the set up page formats and the programming flow diagram

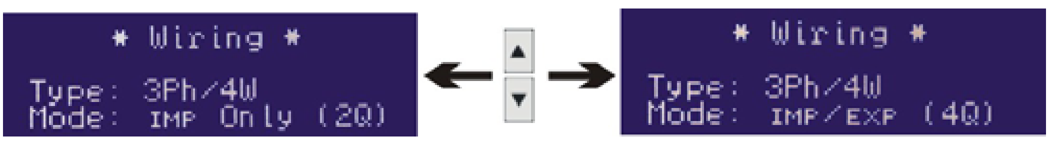
NOTE: all new setting and/or alteration of the instrument programming parameters become effective only upon exit from the programming session by pressing the PROGRAM button located on the upper right side of the instrument.

5.1.2 Configuration procedure



5.1.2.1 Electrical system configuration

The first programming page shows the configuration of the type of electrical system.



The first selection sets the type of electrical system and the type of wiring used:

- 3 phase 4 wire Star system **[3Ph/4W]**
- 3 phase 3 wire Delta system **[3Ph/3W]**,
- balanced 3 phase 4 wire system (1 CT only) **[3Ph/4W-Bal]**,
- balanced 3 phase 3 wire system **[3Ph/3W-Bal]**,

- single phase system [1Ph/2W]
- bi-phase system [2Ph/2W].

The second selection sets whether the operating mode is:

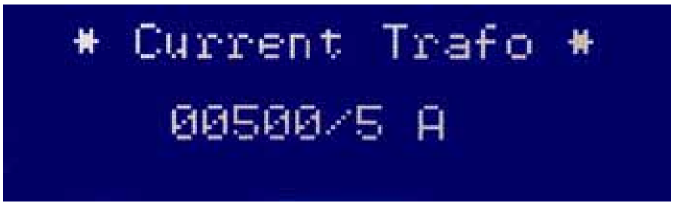
- Import only [Import (2Q)]
- Import-Export [Imp/Exp (4Q)].

The instrument is set by default to [3Ph/4W] and Import [Import (2Q)] mode. This configuration automatically compensates all possible CT output reversal.

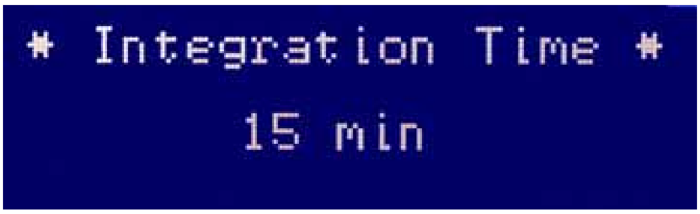
The following page enables to set the type of voltage measurement.

If the voltage measurement is direct in low voltage, select **[Low];** the menu passes directly to the currents setting page.

If the voltage measurement is made on the HT side and/or via a voltage transformer, select **[High]** and proceed to the next page for setting the Volatge transformer (PT) primary and secondary values
Enter the PT <u>rated</u> primary and secondary values indicated on the PT label; the values taken by measurement are unsuitable to this purpose.
The primary and the secondary values must be integers, the ratio can also be fractional.
The instrument is set by default to **[Low]**
After the voltage setting, the current set up page is prompted for programming the CT values; it requires the entry of the CT primary rating and the CT secondary rating.



Ensure to enter the CT <u>rated</u> primary and secondary values as indicated on the CT label.
When using 2 or 3 current transformers ensure that all the current transformers have the same ratings.
The instrument is set by default to **[00005/5]**.
The next page allows to set the integration time for calculating the Average and the Maximum Demand.



The value is expressed in minutes in a 1 to 60 min. range.

The instrument supports two average values: one calculated by using the sliding window method and the other one calculated on a fixed time basis. The time setting that is programmed by keyboard is the average demand integration time with the sliding window method. The Maximum Demand too is calculated on the sliding window basis.
The integration time on a fixed time basis is used for storing the energy data however this setting is available only as a MODBUS register via serial port setting.

5.1.2.2 Communication characteristics configuration

This menu appear only upon connection to the instrument of an RS-485 or an RS-232 optional module.
The setting of the RS485 communication characteristics requires to scroll the programming pages with two keys;

The 

key advances to the next page, the 

key returns to the previous page

The first page is the following:
This page enables the setting of respectively:
- communication speed
- number of data bits
- parity
- stop bits

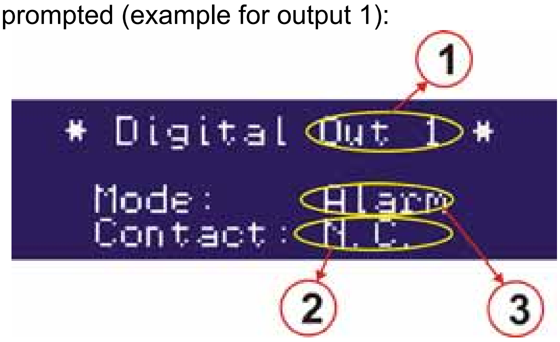
All these data are correlated depending upon the stop bit value.
Additional parameters regarding the MODBUS communication protocol may be set in the next page:

- Mode: it may be configured to RTU or to ASC (ASCII) mode.
- Slave Address
- Transmission delay; it stands for the time delay the instrument will wait prior to reply to a data query. It is expressed in milliseconds, the default value is 100 msec and a 0 setting is also possible.

5.1.2.3 Digital Outputs configuration

The instrument is equipped with 2 digital outputs that are set by default to operate as pulse outputs proportional to P_Σ (output 1) and Q_Σ (output 2) at a rate of 1.000 pulses per kWh (or kvarh) referred to the instrument range without any CT and PT multiplier.

The operating mode of digital outputs may be changed to operate as alarm output or as remote output device controlled by the Modbus protocol.
When operating on the Modbus protocol, in order to ensure a protection to the outputs in case of communication failure, it is possible to configure a watchdog timer (programmable from 0 to 60 minutes; 0 = disabled).
The following entry fields are prompted (example for output 1):



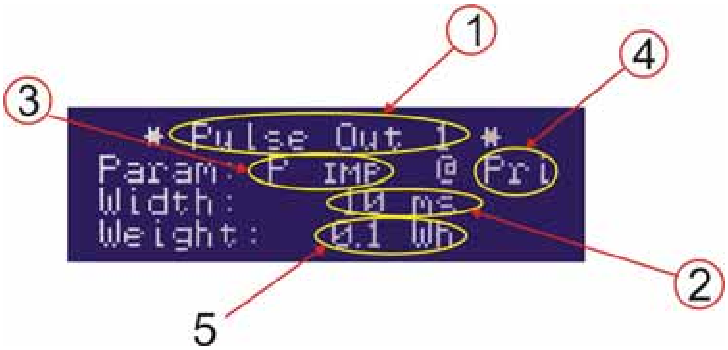
(1) Digital out number being programmed.
(2) Contact: it configures the rest state of the output transistor.
    n.c. normally closed or **n.o.** normally open:

(3) Mode of operation**:**
    PULSE (default setting) for operation as pulse output
    ALARM for operation as alarm contact output
    Remote for operation as remote output device controlled via Modbus

The procedure for programming the digital output 2 is identical.

5.1.2.4 Pulse characteristics configuration

If the PULSE selection is operated, the following page is shown allowing the configuration of the pulse characteristics:



Where:

(1) Pulse output number being programmed.

(2) Pulse duration in mSec; programmable from 50 up to 900 in steps of 10.

(3) Parameter selected for pulse transmission: It may be selected among:

P imp	Import Active Power
QL imp	Reactive power (inductive) with import Active Power
Qc imp	Reactive power (capacitive) with import Active Power
S imp	Apparent power with import Active Power
P exp	Export Active Power
QL exp	Reactive power (inductive) with export Active Power
Qc exp	Reactive power (capacitive) with export Active Power
S exp	Apparent power with export Active Power

(4) Pri: the pulses take into account the CT and PT ratio and are referred to their primary readings
Sec: the pulses are referred to the CT (and PT) secondary reading without any multiplier .

(5) Pulse **weight**: programmable from 0,1 Wh up to 1 MWh through all the intermediate steps.
Example: 1.0 Wh = 1000 pulses/kWh.

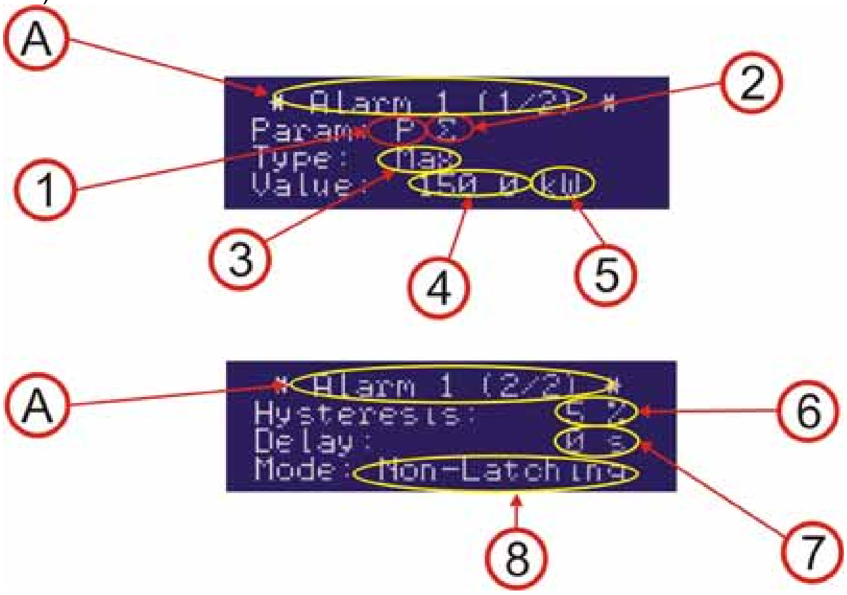
5.1.2.4.1 Pulse output set up with Modbus registers.

To set up the pulse output the Modbus Holding Registers from 120 to 127 have to be used.
Refer to chapter 9 for the details.

5.1.2.5 Alarm configuration

The Instrument is equipped with two alarms that are triggered by a programmable threshold on anyone of the measured parameters.
The types of alarm available are: maximum, minimum and 1-of-3.
A minimum alarm is triggered when the selected parameter is lower than the alarm threshold.
A maximum alarm is triggered when the selected parameter exceeds the alarm threshold.
A 1-of-3 alarm is triggered when anyone of the phase readings, whichever the phase involved, trespasses the alarm threshold – this alarm can be either maximum or minimum. On a 1-of-3 current alarm, the threshold is expressed as percentage (rather than a value) that stands for the unbalance between the phases. The alarm therefore triggers when the percent difference between two of the three phases exceeds the threshold; it is calculated as 100 x ($I_{max} – I_{min}$)/I_{max}.
All alarms allow also the setting of an hysteresys and a delay time.
The **hysteresys** (in percent) sets the difference between the triggering threshold and the end threshold (this prevents repeated alarm triggering when the reading oscillates around the trigger value). Example: a 5% hysteresys on a threshold of 100, triggers the alarm when the reading exceeds 100 but it will switch off the alarm when the reading becomes lower than 95.
The **delay time** sets a time delay for triggering on the alarm after its actual occurrence (or triggering off after its actual end).

The set up of each alarm is performed on two programming pages prompting the following entry fields (example for Alarm 1).



(A) Alarm No. and page No. identification (**AL1** = alarm 1 that may be associated to output 1)

(1) Parameter type applying to Alarm 1. The possible choices are:

None	Disabled
U	Voltage
f	Frequency
I	Current
P	Active Power
Q	Reactive Power
S	Apparent Power
PF	Power Factor
U THD	Total Harmonic Distortion (Voltage)
I THD	Total Harmonic Distortion (Current)

(2) Parameter definition: The possible choices are:

LN	Average star value (applicable to voltage, current and THD only).
LL	Average system value (applicable to voltage and THD only).
N	Neutral value (applicable to current only)
Σ	Three phase value (applicable to active, reactive and apparent power only)
L1	Phase 1 value.
L2	Phase 2 value.
L3	Phase 3 value.
L1-L2	Phase-phase (L1-L2) value (applicable to system voltages and THD only)
L2-L3	Phase-phase (L2-L3) value (applicable to system voltages and THD only)
L3-L1	Phase-phase (L3-L1) value applicable to system voltages and THD only)
1÷3 LL	Value applicable to all the three phase-phase readings of voltage or THD.
1÷ 3 LN	Value applicable to all the three phase-neutral readings of current, voltage or THD.
AVG	Average value (applicable to average powers – demand - only).

(3) Alarm type
M = maximum
m = minimum

(4) Threshold value: programmable in the range –1999 +1999

(5) Decimal point: the parameter value may be scaled to the powers of ten by using the m, K, M symbols and the decimal point. Range is between 10^{-3} a 10^{9}.

(6) Hysteresys: value, from 0% to 99%

(7) Delay time: from 0 to 99 seconds

(4) Output trigger mode:
Non-latching = normal (the relay is active for the duration of the alarm),
Pulsed = pulsed (the alarm triggering generates a pulse).

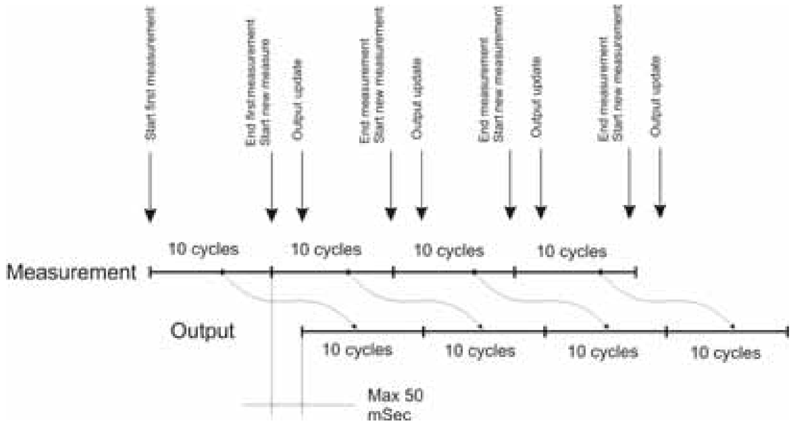
The Alarm 2 programming procedure is identical.

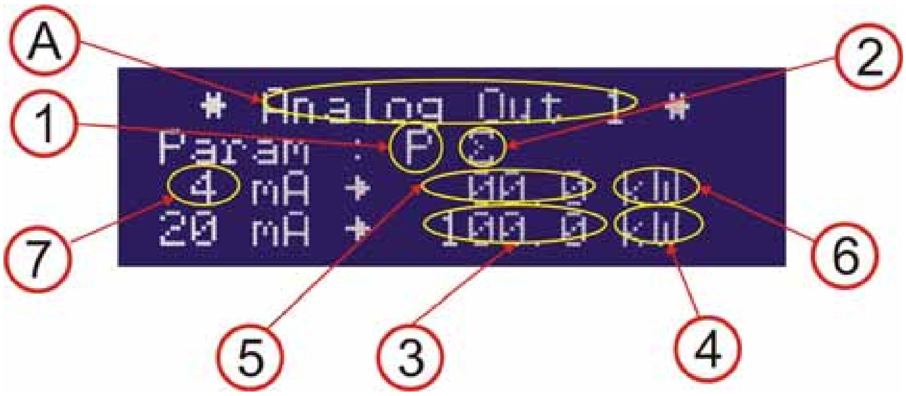
5.1.2.5.1 Alarm set up with Modbus registers.

To set up the alarm t the Modbus Holding Registers from 95 to 106 have to be used.
Refer to chapter 9 for the details.

5.1.2.6 4-20 mA Analog Outputs configuration.

The instrument supports two 4-20 mA or 0-20 mA analog outputs with 500 ohms maximum load. Each output is to one of the parameters handled by the instrument.
The output is updated every 10 cycles of the network frequency (i.e. every 200mSec with 50 Hz mains) with a maximum delay of 50 mSec from the actual measurement.





(A) Output identification: **A.o.1** = analog output 1.

(1) Parameter applying. The possible choices are:

None	Disabled
U	Voltage
f	Frequency
I	Current
P	Active Power
Q	Reactive Power
S	Apparent Power
PF	Power Factor
U THD	Total Harmonic Distortion (voltage)
I THD	Total Harmonic Distortion (current)

(2) Parameter definition: The possible choices are:

LN	Average star value (applicable to voltage, current and THD only).
LL	Average system value (applicable to voltage and THD only).
N	Neutral value (applicable to current only)
Σ	Three phase value (applicable to active, reactive and apparent power only)
L1	Phase 1 value.

L2	Phase 2 value.
L3	Phase 3 value.
L1-L2	Phase-phase (L1-L2) value (applicable to system voltages and THD only)
L2-L3	Phase-phase (L2-L3) value (applicable to system voltages and THD only)
L3-L1	Phase-phase (L3-L1) value applicable to system voltages and THD only)
AVG	Average value (applicable to average powers - demand - only).

(3) Value to be associated to the 20 mA full scale signal; programmable in the range –1999 +1999

(4) Scale; the parameter value may be scaled to the powers of ten by using the m, K, M symbols and the decimal point. Range is between 10^{-3} a 10^{9}.

(5) Value to be associated to the 4 mA (or 0 mA) signal; programmable in the range –1999 +1999.

(6) Scale; the parameter value may be scaled to the powers of ten by using the m, K, M symbols and the decimal point. Range is between 10^{-3} a 10^{9}.

(7) Output type: 4-20 mA or 0-20 mA.

The procedure for programming of the Analogue output 2 is identical.

5.1.2.6.1 Analog output set up with Modbus registers.

To set up the analog output the Modbus Holding Registers from 80 to 91 have to be used.
Refer to chapter 9 for the details.

5.1.2.6.2 Alarms and 4-20 mA output configuration for the average (AVG) parameters

In the Import-Export operating mode, the instrument supports a 4 quadrant measurement, but the selection can be made on one quadrant at a time.

When operating an AVG average selection, the following parameters are prompted.

P IMP AVG	Import Active Power
QL IMP AVG	Reactive power (inductive) with import Active Power.
QC IMP AVG	Reactive power (capacitive) with import Active Power
S IMP AVG	Apparent power with import Active Power
P EXP AVG	Export Active Power (export)
QL EXP AVG	Reactive power (inductive) with export Active Power
QC EXP AVG	Reactive power (capacitive) with export Active Power
S EXP AVG	Apparent power with export Active Power

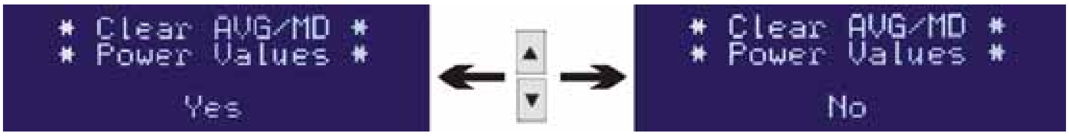
5.1.2.7 Contrast adjustment

The ▲ and ▼ keys allow to adjust the display contract to the viewing angle in a 1 to 15 range.

The display illumination is automatically reduced 3 minutes after the last key pressure .
It will automatically becomes brighter whenever pressing a key again.

5.1.3 Reset Procedure

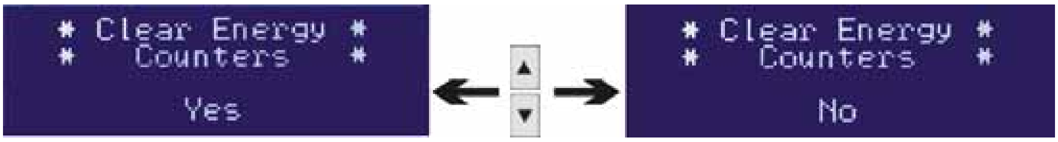
5.1.3.1 Average and Max Demand power Reset



In order to reset the Average Powers, the Maximum Demand and the Energy counters it is necessary to:

- Enter into the programming menu by pressing the PROGRAM button.
- Press the  key to display the powers reset page or the  key to display the energy counters reset page.
- Select YES to reset, NO to skip. Resetting is confirmed by pressing the  key that executes the reset and returns automatically to the readings pages.
- The reset operation clears all the average powers and the Maximum Demand.

5.1.3.2 Energy Reset



It is also possible to exit the procedure, at any time without resetting, by pressing the PROGRAM button.

5.2 Readings

5.2.1 Readings selection keys

The selection of the readings and of the reading pages is made by means of the following keys:

Voltage and frequency key
Currents key
Powers key
Power factor key
Energies key
Life time indicator key
Move the selection up and down in the readings pages
This key is disabled in the readings pages.

5.2.1.1 Voltage and Frequency readings

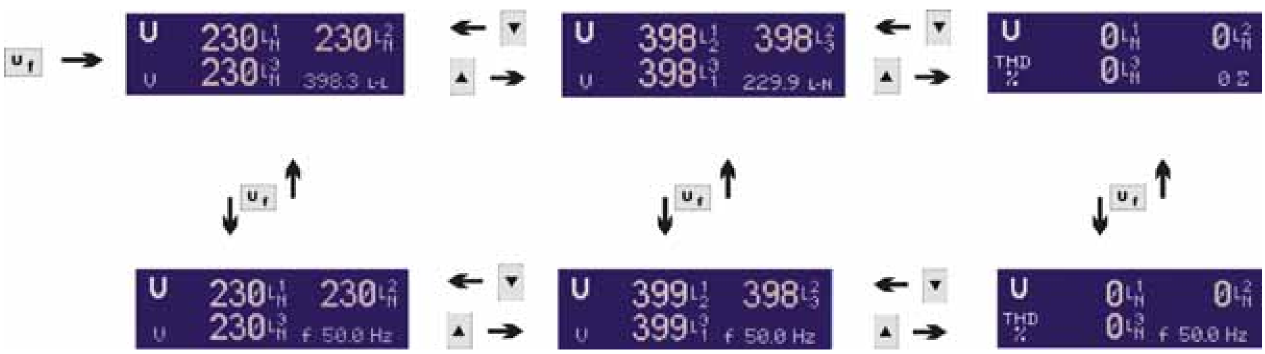
By pressing once the key, a first voltage readings page is prompted showing the phase-neutral voltages and, on the bottom right side of the display, the average 3-phase system voltage.

By pressing the key, a second voltage readings page is prompted showing the phase-phase voltages and, on the bottom right side of the display, the average phase-neutral system voltage.

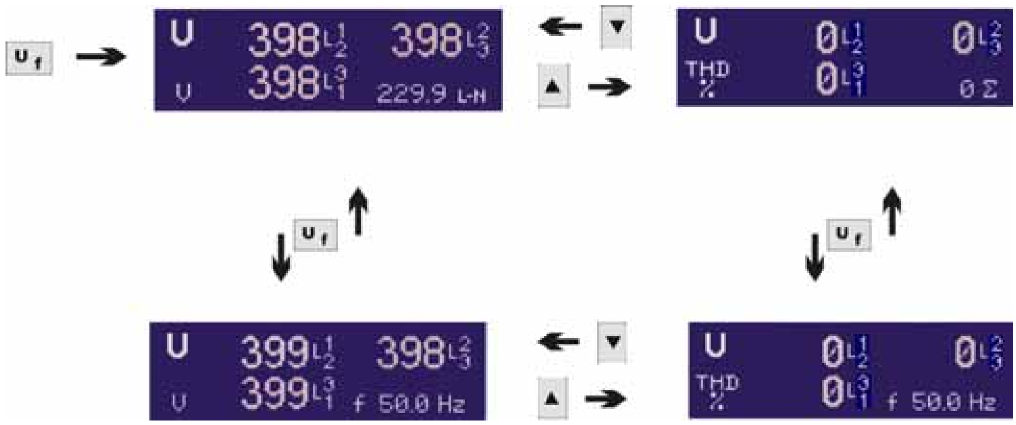
Another pressure of the key prompts the total harmonic distortion readings of the voltage of each phase.

By pressing again the key the frequency is shown on the lower right side on thedisplay.

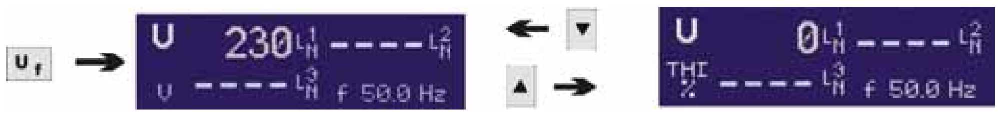
5.2.1.1.1 3P 4 W Configuration



5.2.1.1.2 3P 3 W Configuration

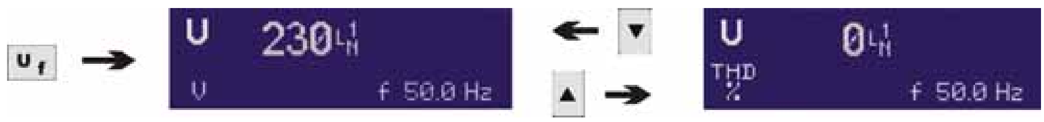


5.2.1.1.3 3P-b 4W Configuration

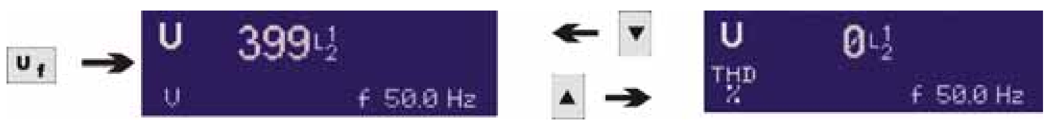


5.2.1.1.4 3P-b 3W Configuration

5.2.1.1.5 1P 2W Configuration



5.2.1.1.6 2P 2W Configuration

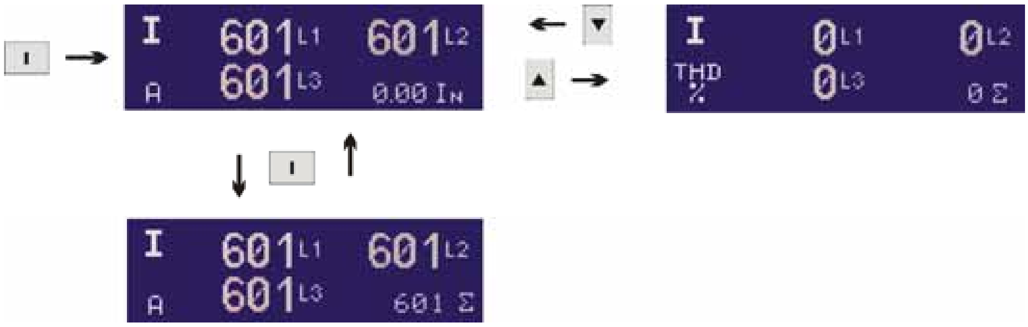


5.2.1.2 Current readings

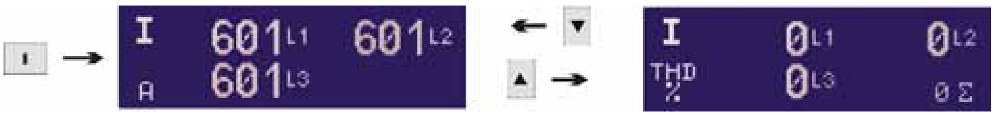
By pressing the key, the current readings page is prompted showing the currents of each phase as well as the neutral current.

A pressure of the key prompts the total harmonic distortion readings of the current of each phase.

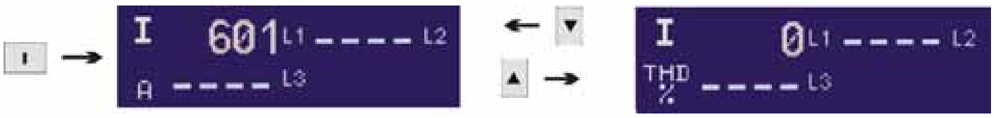
5.2.1.2.1 3P 4W Configuration



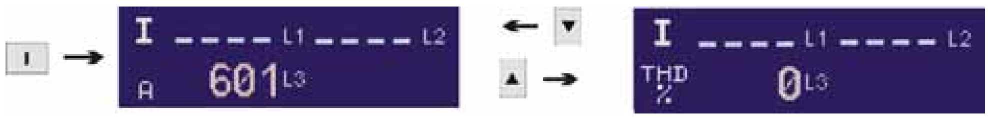
5.2.1.2.2 3P 3W Configuration



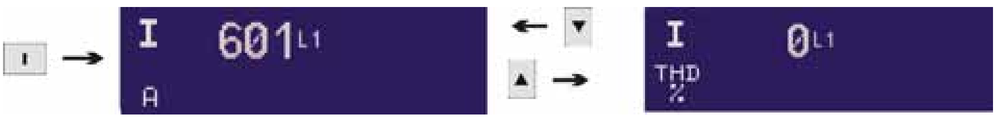
5.2.1.2.3 3P-b 4W Configuration



5.2.1.2.4 3P-b 3W Configuration



5.2.1.2.5 1P 2W and 2P 2W Configuration



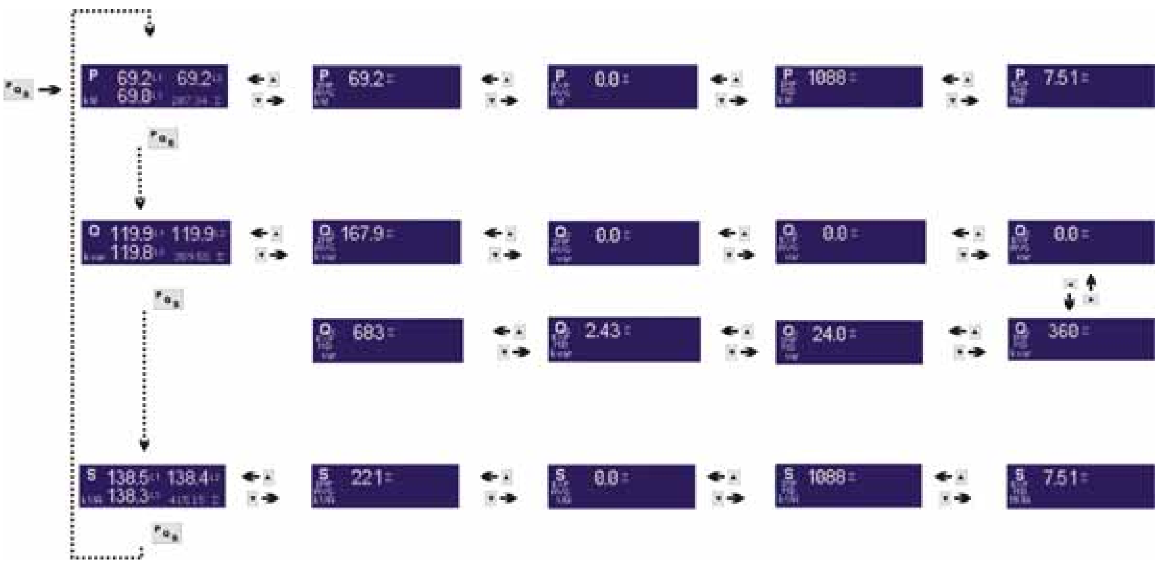
5.2.1.3 Powers

By pressing the key the power reading pages for P Active Power, Q Reactive power and S Apparent power are scrolled in sequence. By pressing the and keys the average and the maximum powers (Demand and Maximum Demand readings) are displayed.

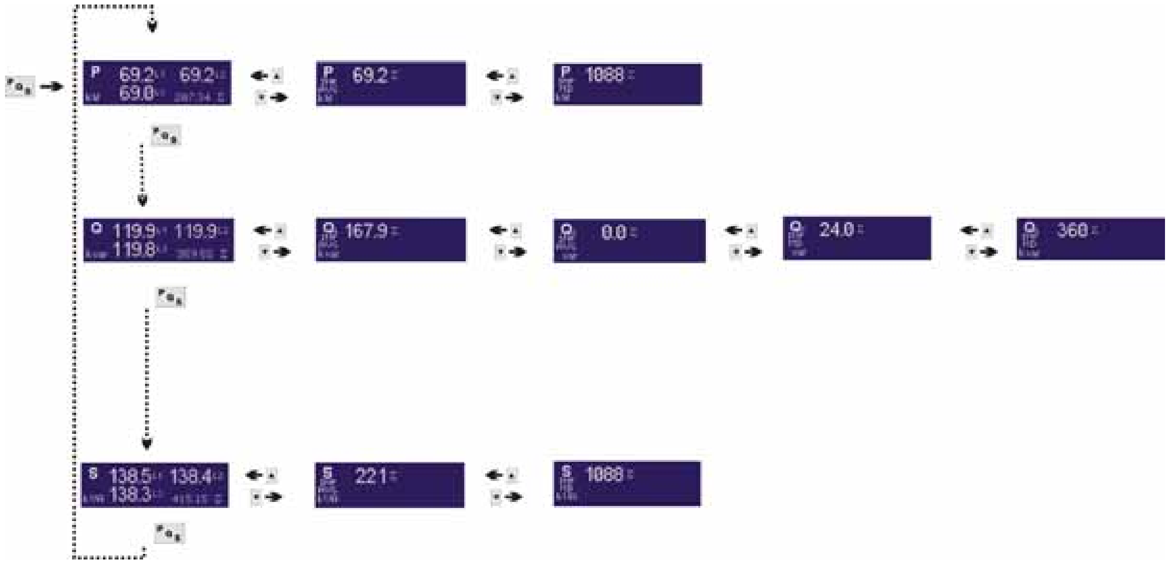
The displayed parameters are :

P	Active power of each phase and three phase
P IMP AVG	Import average Active Power
P EXP AVG	Export average Active Power
P IMP MD	Max Demand on import Active Power
P EXP MD	Max Demand on export Active Power
Q	Reactive power of each phase and three phase
QL IMP AVG	Average reactive (inductive) power with import Active Power
QC IMP AVG	Average reactive (capacitive) power with import Active Power
QL EXP AVG	Average reactive (inductive) power with export Active Power
Qc EXP AVG	Average reactive (capacitive) power with export Active Power
QL IMP MD	Max Demand on reactive (inductive) power with import Active Power
QC IMP MD	Max Demand on reactive (capacitive) power with import Active Power
QL EXP MD	Max Demand on reactive (inductive) power with export Active Power
QC EXP MD	Max Demand on reactive (capacitive) power with export Active Power
S	Apparent power of each phase and three phase
S IMP AVG	Average apparent power with import Active Power
S EXP AVG	Average apparent power with export Active Power
S IMP MD	Max Demand on apparent power with import Active Power
S EXP MD	Max Demand on apparent power with export Active Power

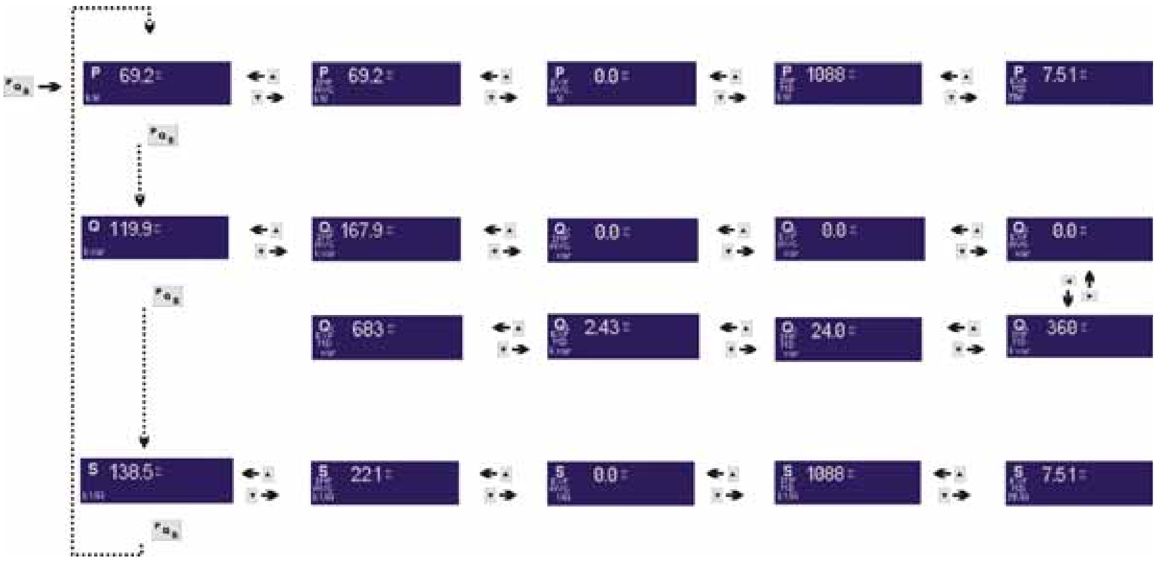
5.2.1.3.1 3P 4W Configuration



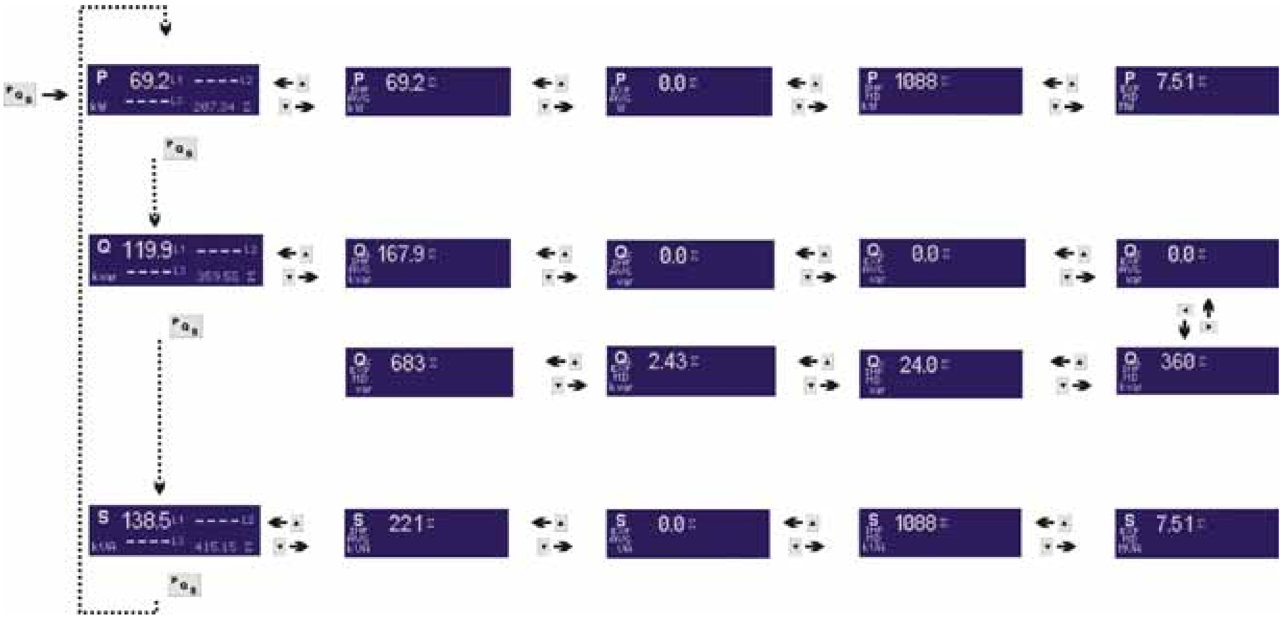
5.2.1.3.2 3P 4W only Import Configuration.



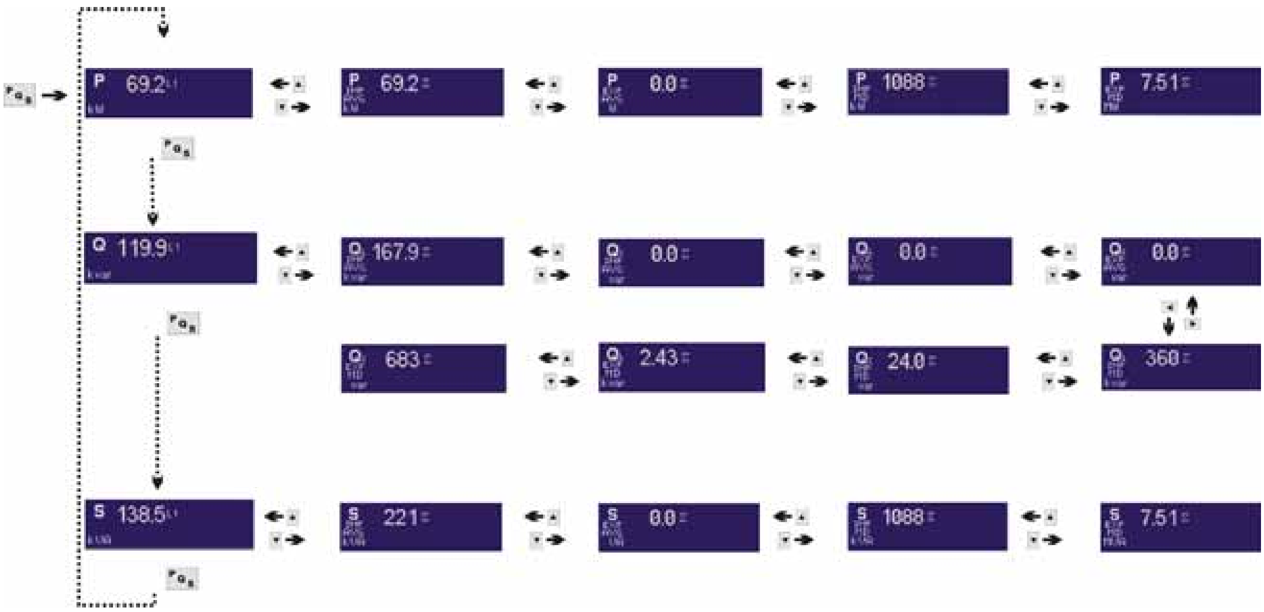
5.2.1.3.3 3P 3W / 3P-b 3W / 2P 2W Configuration



5.2.1.3.4 3P-b 4W Configuration



5.2.1.3.5 1P 2W Configuration



5.2.1.4 P.F. Visualization

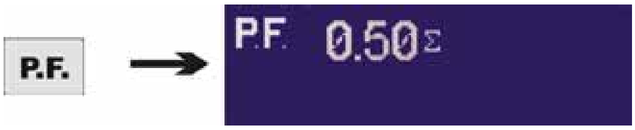
By pressing the  key, the power factor readings page is prompted showing the PF of each phase as well as the 3-phase reading. Only one page is displayed.

The – sign ahead of the value identifies a capacitive (leading) reading.

5.2.1.4.1 3P 4W Configuration

5.2.1.4.2 3Pb 4W Configuration

5.2.1.4.3 3P 3W e 3Pb 3W Configuration



5.2.1.4.4 1P 2W e 2P 2W Configuration

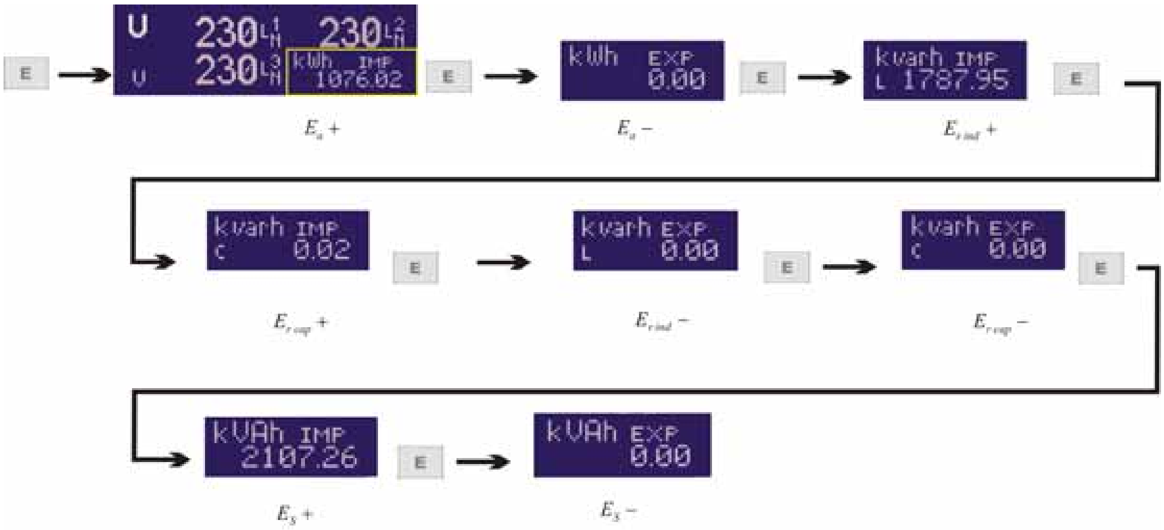
5.2.1.5 Life Time

By pressing the  key the life time reading are displayed.

The life time is the instrument operating time (when powered on) since it was manufactured.
The readings is expressed in hours and hour hundredths; it can reach 99.999 hours equal to 11 years. The life time reading reset is not possible.

5.2.1.6 Energies

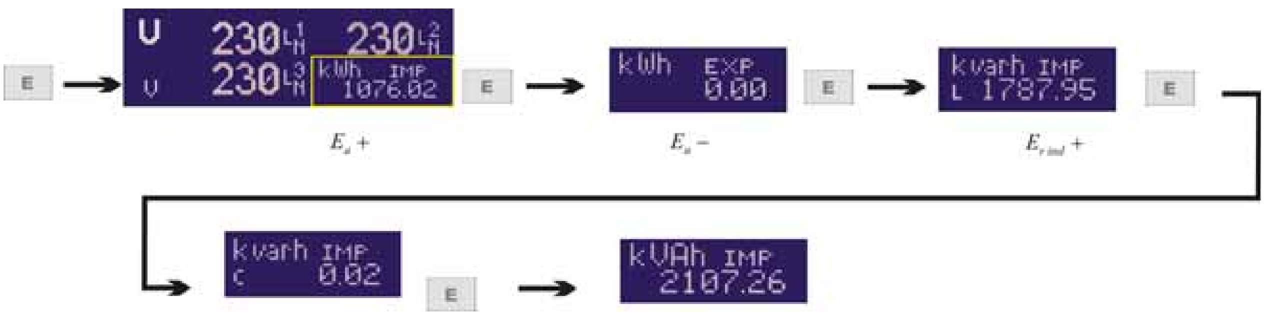
By pressing repeatedly the E key, the several energy readings will be displayed consecutively on the lower right part of the screen.
The energy readings may be recalled at any time irrespective the readings page being displayed.
The energy readings will however disappear upon selection of another readings page but they may be recalled, at any time, by pressing the E key.



Where:

(E_a^+)	Import active energy
(E_a^-)	Export active energy
$(E_{r\,ind}^+)$	Reactive energy (inductive) with import Active Power
$(E_{r\,cap}^+)$	Reactive energy (capacitive) with import Active Power
$(E_{r\,ind}^-)$	Reactive energy (inductive) with export Active Power
$(E_{r\,cap}^-)$	Reactive energy (capacitive) with export Active Power
(E_s^+)	Apparent energy with import Active Power
(E_s^-)	Apparent energy with import Active Power

5.2.1.7 Only Import Energy Display



6 Instrument Description

6.1 Introduction

FLASH D is a microprocessor based energy analyzer with leading edge flexibility and accuracy.
The patented digital measuring system guarantees high performance with age and thermal stability. This is achieved through sophisticated strategies of automatic offset compensation - used throughout the measurement chain – and through a Phase Locked Loop (PLL) sampling probe.

The automatic rescaling feature on current inputs allows a wide measuring range - from *20mA* to *6A* in direct connection.
All “true-RMS” measures are obtained with continuous sampling of the voltage and current waveforms: this guarantees maximum precision even when rapidly changing loads are present (e.g. electric welding machines).
FLASH D can be programmed to analyze three phase networks, both on three and four wires with low or high voltage with 1, 2 or 3 CTs in addition to single phase measurements. The option of setting any required conversion factor on the voltage and current inputs makes FLASH D suitable for use in both high and low voltage networks.
It can measure the energy and the peak on the 4 quadrants (active, reactive and apparent).
The instrument firmware is kept in flash memory and can be updated through a serial port, using the same communication protocol. The upgrade uses special security provisions to ensure continued operations even in presence of communication failures.
All input, output, and power supply ports are electrically separated for maximum safety and noise reduction under any operating conditions.
The in-house testing and calibration process is completely automated: a conformity certificate and calibration report are supplied with each unit.
The LCD display has three 3 ½ digit lines and a 7 digit line and an extended symbol and character set, allowing the simultaneous display of 4 measurements. Three 11-segment bar graphs give immediate feedback on the overall measuring process.
The wide keyboard, with its 9 silicon rubber coated keys, clearly marked with function, allows a simple and intuitive use of the instrument.
FLASH D is completely programmable, from either the keyboard or a PC remote connection (only for models with communication port). It is therefore the ideal solution for all the power measurement and management needs in the industrial environment.
The instrument is equipped with two optically insulated transistor driven outputs with capacity load of 27 Vdc 27 mA according to 43864 Din standard.
They can be used either as pulse output or as alarm and are fully programmable by the user on different parameters and with different pulse frequency and duration.
The factory setting is with one output is proportional to the active energy, while the other to the reactive energy and an output frequency of 1000 pulses per kWh (or kvarh) and 50 ms pulse time.
The pulses number is referred to the instrument end of range without the CT and VT scale factors.

6.2 Simplicity and versatility

Keyboard programming is extremely easy and allows setting of:

- Connection type (star and delta)
- Low Tension or Medium Tension
- Setting of CTs and VTs values (freely settable)
- Integration time (1-99 min.)
- RS485 features (speed, parity and data format)
- Alarm threshold
- Analog output.
- Pulses
- ...and all other functions available

The sameFunctions can be programmed via PC

6.3 Total harmonic distortion Measurement (THD)

The instrument gives an evaluation of the energy quality by sampling the total harmonic distortion of the 3 voltages and 3 currents.

These functions are extremely useful to control the quality of the energy supplied by the Public Utility, because of the large number of distorting loads in industrial plants.

6.4 Energy Measurement

Energy is displayed on a 6 digit display with floating point.

The energy counters are stored on counters with minimum definition equal to 0,1 Wh and maximum counting equal to 99.999.999,9 kWh.

8 counters are available +Ea, -Ea, ++Er, -+Er, +-Er, --Er, +Es, -Es on 4 quadrant.

6.5 Calibration Led

A red led is located on the instrument front panel pulsing with a 1000 pulse/kWh (or kvarh) and 50 ms pulse duration. The pulses number is referred to the instrument end of range without the CT and VT scale factors.

6.6 Digital Outputs

The two outputs are (mostly) used as pulse output on active/reactive power or as output for the internal triggers. In other configurations, where the instruments is controlled – by a PC or PLC - through the RS485 port, the outputs can be used for signaling remote activation/deactivation.

6.7 Oulse Output

The two outputs, if in association with pulse, can be referred to one of the 8 power value available on a 4 quadrant system.

The output pulse can be freely programmed both on frequency and duration and referred to the instrument Full Scale or to the measuring cell (with CT and PT) Full Scale.

It is possible to program the output value either according to pulse number and pulse weight

The two outputs are factory programmed one proportional to the active energy while the other to the reactive energy, the output frequency is 1000 pulses per kWh (or kvarh) and 50 ms pulse time.

The pulses number is referred to the instrument Full Scale without the CT and TV scale factors.

6.8 Alarms

FLASH D is triggered and programmed by switchboard and/or Holding registers with MODBUS protocol.

The advanced functions of the Energy Brain configuration software allow to customize each of the two alarms on any available parameter either as a minimum or max alarm. Two different thresholds of the same measurement can be programmed.

Minimum value and maximum value special alarms on voltage are available that can be applied on any of the three phases, one maximum value alarm on current that can be applied on any of the three phases and an unbalanced alarm on any of the three current phases.

A further flexibility in customization is provided by the possibility to program the alarm management through:

- Delay time (between 1 and 59 sec.) that is activation delay. Example: avoid alarms due to short signal peaks.
- Hysteresis, that is the cycle between the alarm activation value and the alarm deactivation value. It is an extremely useful function to avoid ringing and false triggering. Example: Current alarm set on 100A Max with 5% Hysteresis. The alarm is activated at 100 A and is deactivated at 95 A. The two alarms can be associated singularly to:
- Output relays. In this case the output relays are activated by the exceeded threshold
- RS485 data line. The relays are disabled and the alarm consolidation are disabled and the alarm condition is available as information on information on RS485. data line.

6.9 Communication

The device can be connected to a PC through an optional RS485 or RS232 port using the MODBUS communication protocol (MODBUS, developed by AEG-MODICON, is a standard in the PLC industry and widely utilized by SCADA systems for industrial plants management).
Data read by the device can be read as the content of numeric registers, in the standard mantissa/exponent floating point IEEE format.
The communication port can be operated at any speed between 2400 bps through 38400 bps without wait states between 2 requests with a limitation on the number of registers equal to 124 registers (62 parameters)
When using the optional RS485 port, the connection uses a standard telephone pair without need of signal regeneration/amplification for distances up to 1,000 m. Up to 128 devices can be connected on the same network branch. Using line amplifiers, it is possible to connect up to 247 instruments or 1,000 m network segments.

6.10 Average and peak Energy

While the FLASH D was designed to measure energy consumption (the so called import mode), it can be configured to work in import/export mode. When in import mode, the device automatically compensates wiring errors on CTs (e.g. for current flow). On the other hand, when in import/export mode, all the energy, average and peak counters are open for measures in the four quadrants.

7 System Architecture

7.1 General Features

7.1.1 FLASH D

Energy Analyzer

- Very accurate and stable measurement system thanks to the digital signal elaboration;
- Continuous sampling of the wave shape of voltages and currents;
- Offset automatic compensation of the measurement chain;
- Current inputs with automatic scale change;
- True-RMS measurements (up to the 31st harmonic);
- Class 1 on the Active Power in compliance with IEC EN 61036;
- Neutral current calculation;
- Working temperature -20/+60 °C.
- Programmable digital outputs
- Insertion on electric 3 phase unbalanced 3 or 4 wire networks, single phase networks and on balanced symmetrical three phase 3or 4 wire networks
- Software upgrade on line
- Life Timer;
- LCD display with white white LED baclight;
- Calibration verification LED through optical devices;
- Easy to use, thanks to the 9 button keyboard with explicit function indication;
- To be used with low or high voltages (programmable relationship between VTs and CTs);
- Extended range power supply (*85 ÷ 265 Vac*, *100 ÷ 374 Vdc*) separated from the measurement inputs;
- 2 slots for optional expansion modules:
  - RS-232 o RS-485 Communication port;
  - 4-20 mA Double analogue output;
  - Further devices for future applications;
- Galvanic insulation among all input and output ports;
- Firmware which can be upgraded to support new functions;
- 6 unit Din rail mounting;
- Compliant with all the international standards.
- Measurement of the total harmonic distortion (THD) of voltages and currents;
- Average and Max Demand powers (on 4 quadrants) with programmable integration time;

- Internal energy counters (on 4 quadrants).
- 2 digital outputs (DIN 43864) with programmable functions:
  - Pulse outputs for energy counting;
  - Event signaling (alarms);
  - Remote control of external devices.

7.1.2 Options

7.1.2.1 RS485 Port

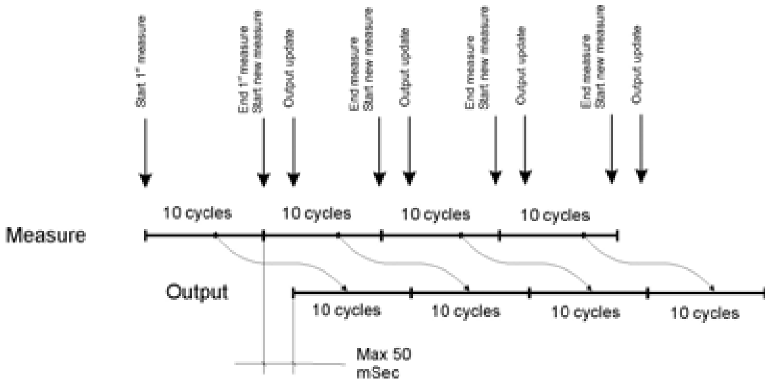
RS485 optically insulated interface module with programmable speed from 2400 bps to 38400 bps.
It is connected to the instrument via a connector and then can be easily fixed at the back with screws.
It can be network connected with other instruments up to 1000 m maximum distance and up to 128 instruments. For longer distances or more instruments, an amplifier is necessary.

7.1.2.2 RS232 Port

RS232 optically insulated interface module with programmable speed from 2400 bps to 38400 bps.
It is connected to the instrument via a connector and then can be easily fixed at the back with screws.

7.1.2.3 2 x 4-20 mA Analog Output

4-20 o 0-20 mA analogue double output, galvanically insulated with high precision and reliability.
The output is the result of a conversion from digital to analogue with definition higher than 10 bit, maintaining the original measurement accuracy.
The two outputs can be linked to any measurement parameter with update every 200 ms on primary parameters.

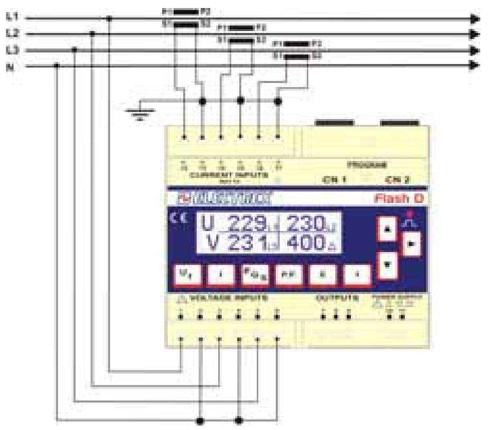


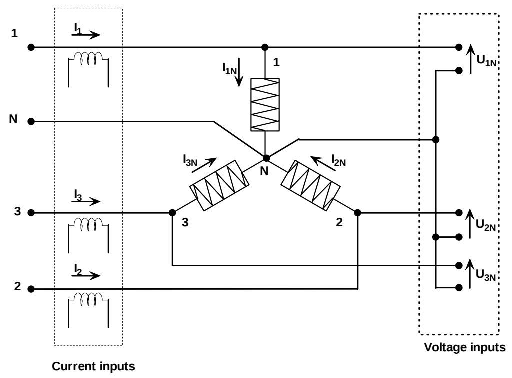
For the average power the output update is every minute due to the parameter itself.
It can be set to a 0 value (4 or 0 mA) a positive or negative value of the selected parameter and to nevertheless set to 20 mA end of scale, a lower value than the instrument end of scale. The end of scale provides for an operation margin up to 24 mA.
If the parameter has a value different from the set ones, the output will be 0 mA.

8 Parameters and formulas

For each type of connection, the available readings as well as the formulas used for their calculation are provided.
The readings not available will be displayed as - - - in place of the value.

8.1 3P 4W Three phase with 4 wire neutral





8.1.1 Available Reading:

1 Frequency:

1.1 Voltage frequency V_{1N} : f

2 RMS amplitude:

2.1 Phase Voltages: U_{1N}, U_{2N}, U_{3N}

2.2 Average Phase Voltages: U_{λ}

2.3 Phase-phase Voltages: U_{12}, U_{23}, U_{31}

2.4 Mean Phase-phase Voltage: U_{Δ}

2.5 Phase Current: I_1, I_2, I_3

2.6 Neutral Current: I_N

2.7 Mean three phase Current: I_{Σ}

3 Total harmonic Distortion (in percentage):

3.1 Phase Voltages THD:

$$THD_{U_{1N}}, THD_{U_{2N}}, THD_{U_{3N}}$$

3.2 Mean 3 phase voltage THD: $THD_{U_{\lambda}}$

3.3 Phase Current THD: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

3.4 Mean 3 phase current THD: $THD_{I_{\Sigma}}$

4 Power (on the short period):

4.1 Phase Active Powers: P_1, P_2, P_3

4.2 3 Phase Active Power: P_{Σ}

4.3 Phase reactive Powers: Q_1, Q_2, Q_3

4.4 3 Phase Reactive Power: Q_{Σ}

4.5 Phase apparent Powers: S_1, S_2, S_3

4.6 3 Phase Apparent Power: S_{Σ}

5 Power Factor:

5.1 Phase Power Factor: $\lambda_1, \lambda_2, \lambda_3$

5.2 3 Phase Power Factor: λ_{Σ}

6 Energies:

6.1 Active Energy (import): E_a^+

6.2 Active Energy (export): E_a^-

6.3 Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

6.4 Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

6.5 Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

6.6 Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

6.7 Apparent Energy with import Active Power: E_s^+

6.8 Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period "Sliding Average",

7.1 Average import Active Power: P_{AVG}^+

7.2 Average export Active Power: P_{AVG}^-

7.3 Average inductive reactive Power with import Active Power: $Q_{AVG\,ind}^+$

7.4 Average capacitive reactive Power with import Active Power: $Q_{AVG\,cap}^+$

7.5 Average inductive reactive Power with export Active Power: $Q_{AVG\,ind}^-$

7.6 Average capacitive reactive Power with export Active Power: $Q_{AVG\,cap}^-$

7.7 Average apparent Power with import Active Power: S_{AVG}^+

7.8 Average apparent Power with export Active Power: S_{AVG}^-

8 Maximum Demand:

8.1 M.D. of import Active Power $P_{M.D.}^+$

8.2 M.D. of export Active Power: $P_{M.D.}^-$

8.3 M.D. of inductive reactive Power with import Active Power: $Q_{M.D.ind}^+$

8.4 M.D. of capacitive reactive Power with import Active Power: $Q_{M.D.cap}^+$

8.5 M.D. of inductive reactive Power with export Active Power: $Q_{M.D.ind}^-$

8.6 M.D. of capacitive reactive Power with export Active Power: $Q_{M.D.cap}^-$

8.7 M.D. of apparent Power with import Active Power: $S_{M.D.}^+$

8.8 M.D. of apparent Power with export Active Power: $S_{M.D.}^-$

9 Energy Values over the programmed integration period

9.1 Active Energy (import):	$E^{+}_{a\,H}$
9.2 Output Active Energy:	$E^{-}_{a\,H}$
9.3 Inductive reactive energy with import Active Power:	$E^{+}_{r\,ind\,H}$
9.4 Capacitive reactive energy with import Active Power:	$E^{+}_{r\,cap\,H}$
9.5 Inductive reactive energy with export Active Power:	$E^{-}_{r\,ind\,H}$
9.6 Capacitive reactive Energy with export Active Power:	$E^{-}_{r\,cap\,H}$
9.7 Apparent Energy with import Active Power:	$E^{+}_{s\,H}$
9.8 Apparent Energy with export Active Power :	$E^{-}_{s\,H}$

10 Time:

10.1	Life Timer	t

8.1.2 Measurement Formulas:

Phase Voltages: U_{1N}, U_{2N}, U_{3N}

$$U_{1N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}^2(n)}; \qquad U_{2N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{2N}^2(n)}; \qquad U_{3N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{3N}^2(n)}$$

Phase-phase Voltages: U_{12}, U_{23}, U_{31}

$$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1}[U_{1N}(n) - U_{2N}(n)]^2}; \quad U_{23} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1}[U_{2N}(n) - U_{3N}(n)]^2}; \quad U_{31} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1}[U_{3N}(n) - U_{1N}(n)]^2}$$

where:

$U_{1N}(n), U_{2N}(n), U_{3N}(n)$ are the star voltage samples;

M is the number of samples taken over a period (64);

M

Phase-Neutral Voltage THD $THD_{U_{1N}}, THD_{U_{2N}}, THD_{U_{3N}}$ in %

$$THD_{U_{1N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{1N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{1N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{1N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{2N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{2N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{2N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{2N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{3N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{3N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{3N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{3N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Currents (coincident with the phase currents): I_1, I_2, I_3

$$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}; \qquad I_2 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_2^2(n)}; \qquad I_3 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_3^2(n)}$$

$I_1(n), I_2(n), I_3(n)$ are the samples of the line currents.

Neutral Current I_N

$$I_N = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1}[I_1(n) + I_2(n) + I_3(n)]^2}$$

Phase Currents THD: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{I_2}=100\sqrt{\frac{\sum_{n=0}^{N-1} I_2^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_2(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2+\left[\sum_{n=0}^{N-1} I_2(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}}-1}$$

$$THD_{I_3}=100\sqrt{\frac{\sum_{n=0}^{N-1} I_3^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_3(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2+\left[\sum_{n=0}^{N-1} I_3(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}}-1}$$

<u>Phase Active Powers:</u> P_1, P_2, P_3;

$$P_1=\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n)\, I_1(n); \qquad P_2=\frac{1}{M}\sum_{n=0}^{M-1} U_{2N}(n)\, I_2(n); \qquad P_3=\frac{1}{M}\sum_{n=0}^{M-1} U_{3N}(n)\, I_3(n)$$

<u>Phase Reactive Powers:</u> Q_1, Q_2, Q_3

$$Q_1=\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n+M/4)\, I_1(n); \qquad Q_2=\frac{1}{M}\sum_{n=0}^{M-1} U_{2N}(n+M/4)\, I_2(n);$$

$$Q_3=\frac{1}{M}\sum_{n=0}^{M-1} U_{3N}(n+M/4)\, I_3(n)$$

<u>Phase Apparent Powers:</u> S_1, S_2, S_3 $\quad S_1=U_1 I_1 \quad S_2=U_2 I_2 \quad S_3=U_3 I_3$

<u>Phase Power Factors</u>: $\lambda_1, \lambda_2, \lambda_3$ $\quad \lambda_1=\frac{P_1}{S_1} sign(Q_1) \quad \lambda_2=\frac{P_2}{S_2} sign(Q_2) \quad \lambda_3=\frac{P_3}{S_3} sign(Q_3)$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

<u>Mean phase-neutral Voltage</u> U_λ $\quad U_\lambda=\frac{U_{1N}+U_{2N}+U_{3N}}{3}$

Mean phase-phase Voltage U_Δ $\quad U_\Delta=\frac{U_{12}+U_{23}+U_{31}}{3}$

<u>Average THD of the star voltages</u>: THD_{U_λ} $\quad THD_{U_\lambda}=\frac{THD_{U_{1N}}+THD_{U_{2N}}+THD_{U_{3N}}}{3}$

<u>Three phase Current</u> I_Σ $\quad I_\Sigma=\frac{S_\Sigma}{U_\Delta\sqrt{3}}$

<u>Average THD of the phase currents</u>: THD_{I_Σ} $\quad THD_{I_\Sigma}=\frac{THD_{I_1}+THD_{I_2}+THD_{I_3}}{3}$

<u>Total Active Power:</u> P_Σ $\quad P_\Sigma=P_1+P_2+P_3$

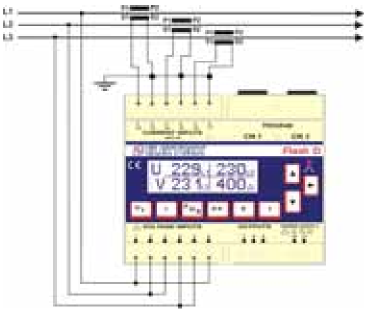
<u>Total reactive Power:</u> Q_Σ $\quad Q_\Sigma=Q_1+Q_2+Q_3$

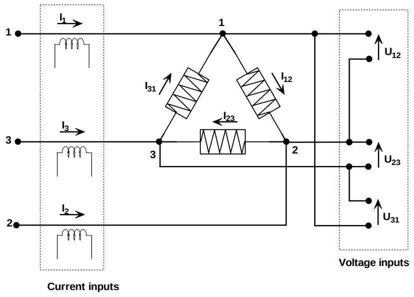
<u>Total apparent Power:</u> S_Σ $\quad S_\Sigma=\sqrt{P_\Sigma^2+Q_\Sigma^2}$

<u>3 Phase Power Factor:</u> λ_Σ $\quad \lambda_\Sigma=\frac{P_\Sigma}{S_\Sigma} sign(Q_\Sigma)$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.2 3P 3W Three phase without neutral





8.2.1 Available Reading:

1 Frequency:

1.1 Voltage frequency V_{1N} : f

2 RMS amplitude:

2.1 Phase-phase Voltages: U_{12}, U_{23}, U_{31}

2.2 Mean Phase-phase Voltage: U_{Δ}

2.3 Line Currents: I_1, I_2, I_3

2.4 Mean three phase Current: I_{Σ}

3 Total harmonic distortion (in percentage):

3.1 THD of the Phase to phase Voltages $THD_{U_{12}}, THD_{U_{23}}, THD_{U_{31}}$

3.2 Average THD of the Phase to phase Voltages $THD_{U\Delta}$

3.3 THD of the line currents: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

3.4 Average THD of the line currents $THD_{I_{\Sigma}}$

4 Power (on the short period):

4.1 3 Phase Active Power: P_{Σ}

4.2 3 Phase Reactive Power: Q_{Σ}

4.3 3 Phase Apparent Power: S_{Σ}

5 Power Factor:

5.1 3 Phase Power Factor: λ_{Σ}

6 Energies:

6.1 Active Energy (import): E_a^+

6.2 Active Energy (export): E_a^-

6.3 Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

6.4 Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

6.5 Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

6.6 Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

6.7 Apparent Energy with import Active Power: E_s^+

6.8 Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period “Sliding Average”,:

7.1 Import average Active Power: P_{AVG}^+

7.2 Export average Active Power: P_{AVG}^-

7.3 Average inductive reactive Power with import Active Power: $Q_{AVG\,ind}^+$

7.4 Average capacitive reactive Power with import Active Power: $Q_{AVG\,cap}^+$

7.5 Average inductive reactive Power with export Active Power: $Q_{AVG\,ind}^-$

7.6 Average capacitive reactive Power with export Active Power: $Q_{AVG\,cap}^-$

7.7 Average apparent Power with import Active Power: S_{AVG}^+

7.8 Average apparent Power with export Active Power: S_{AVG}^-

8 Maximum demand:

8.1 M.D. of import Active Power: $P_{M.D.}^+$

8.2 M.D. of export Active Power: $P_{M.D.}^-$

8.3 M.D. of inductive reactive Power with import Active Power: $Q_{M.D.ind}^+$

8.4 M.D. of capacitive reactive Power with import Active Power: $Q_{M.D.cap}^+$

8.5 M.D. of inductive reactive Power with export Active Power: $Q_{M.D.ind}^-$

8.6 M.D. of capacitive reactive Power with export Active Power: $Q_{M.D.cap}^-$

8.7 M.D. of apparent Power with import Active Power: $S_{M.D.}^+$

8.8 M.D. of apparent Power with export Active Power: $S_{M.D.}^-$

9 Energy Values over the programmed integration period

9.1 Active Energy (import): $E_{a\,H}^+$

9.2 Output Active Energy: $E_{a\,H}^-$

9.3 Inductive reactive energy with import Active Power Power: $E_{r\,ind\,H}^+$

9.4 Capacitive reactive energy with import Active Power: $E_{r\,cap\,H}^+$

9.5 Inductive reactive energy with export Active Power: $E_{r\,ind\,H}^-$

9.6 Capacitive reactive Energy with export Active Power: $E_{r\,cap\,H}^-$

9.7 Apparent Energy with import Active Power: $E_{s\,H}^+$

9.8 Apparent Energy with export Active Power : $E_{s\,H}^-$

10 Time:

10.1 Life Timer t

8.2.2 Measurement Formulas:

Phase-phase Voltages: U_{12}, U_{23}, U_{31}

$$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{12}^2(n)}; \qquad U_{23} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{23}^2(n)}; \qquad U_{31} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{31}^2(n)}$$

$U_{12}(n), U_{23}(n), U_{31}(n)$ are the Phase to phase Voltages samples.
M is the number of samples taken over a period (64)

Phase to phase Voltages THD $THD_{U_{12}}, THD_{U_{23}}, THD_{U_{31}}$ in %

$$THD_{U_{12}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{12}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{12}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{12}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{23}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{23}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{23}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{23}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{31}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{31}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{31}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{31}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Current: I_1, I_2, I_3

$$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}; \qquad I_2 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_2^2(n)}; \qquad I_3 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_3^2(n)}$$

$I_1(n), I_2(n), I_3(n)$ are the line current samples.
Phase Current THD: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{I_2} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_2^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_2(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_2(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{I_3} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_3^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_3(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_3(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Mean phase-phase Voltage U_Δ $$U_\Delta = \frac{U_{12} + U_{23} + U_{31}}{3}$$

Average THD of the Phase to phase Voltages: THD_{U_Δ} $$THD_{U_\Delta} = \frac{THD_{U_{12}} + THD_{U_{23}} + THD_{U_{31}}}{3}$$

Three phase current: I_Σ $$I_\Sigma = \frac{S_\Sigma}{U_\Delta \sqrt{3}}$$

Average THD of the phase Currents: THD_{I_Σ} $$THD_{I_\Sigma} = \frac{THD_{I_1} + THD_{I_2} + THD_{I_3}}{3}$$

Three phase Active Power: P_Σ $$P_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{12}(n)\, I_1(n) - \sum_{n=0}^{M-1} U_{23}(n)\, I_3(n)\right]$$

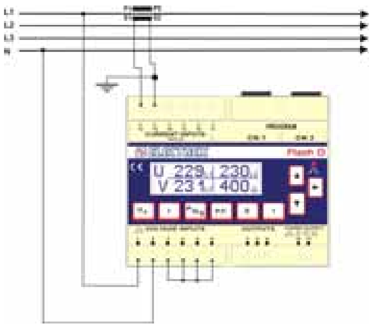
Three phase reactive Power: Q_Σ $$Q_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{12}(n + M/4)\, I_1(n) - \sum_{n=0}^{M-1} U_{23}(n + M/4)\, I_3(n)\right]$$

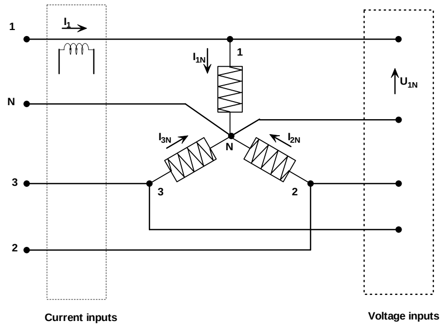
Three phase apparent Power: S_Σ $$S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$$

Three phase Power Factor: λ_Σ $$\lambda_\Sigma = \frac{P_\Sigma}{S_\Sigma} sign(Q_\Sigma)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.3 3P-b 4W Balanced Three phase with neutral





8.3.1 Available Reading:

1 Frequency:

1.1 Voltage frequency V_{1N} : f

2 RMS Amplitude:

2.1 Star Voltage: U_{1N}

2.2 Phase Current: I_1

3 Total harmonic Distortion (in percentage):

3.1 Star Voltage THD: $THD_{U_{1N}}$

3.2 Phase Current THD: THD_{I_1}

4 Power (on the short period):

4.1 Phase Active Power: P_1

4.2 3 Phase Active Power: P_Σ

4.3 Phase Reactive Power: Q_1

4.4 3 Phase Reactive Power: Q_Σ

4.5 Phase apparent Powers: S_1

4.6 3 Phase Apparent Power: S_Σ

5 Power Factor:

5.1 Phase Power Factor: λ_1

5.2 Total Power Factor λ_Σ

6 Energies:

6.1 Active Energy (import): E_a^+

6.2 Active Energy (export): E_a^-

6.3 Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

6.4 Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

6.5 Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

6.6 Capacitive reactive Energy with export Active Power: $E^{-}_{r\,cap}$

6.7 Apparent Energy with import Active Power: E^{+}_{s}

6.8 Apparent Energy with export Active Power: E^{-}_{s}

7 Average Power integrated over the programmed integration period "Sliding Average",

7.1 Import average Active Power: P^{+}_{AVG}

7.2 Export average Active Power: P^{-}_{AVG}

7.3 Average inductive reactive Power with import Active Power: $Q^{+}_{AVG\,ind}$

7.4 Average capacitive reactive Power with import Active Power: $Q^{+}_{AVG\,cap}$

7.5 Average inductive reactive Power with export Active Power: $Q^{-}_{AVG\,ind}$

7.6 Average capacitive reactive Power with export Active Power: $Q^{-}_{AVG\,cap}$

7.7 Average apparent Power with import Active Power: S^{+}_{AVG}

7.8 Average apparent Power with export Active Power: S^{-}_{AVG}

8 Maximum Demand:

8.1 M.D. of import Active Power: $P^{+}_{M.D.}$

8.2 M.D. of export Active Power: $P^{-}_{M.D.}$

8.3 M.D. of inductive reactive Power with import Active Power: $Q^{+}_{M.D.ind}$

8.4 M.D. of capacitive reactive Power with import Active Power: $Q^{+}_{M.D.cap}$

8.5 M.D. of inductive reactive Power with export Active Power: $Q^{-}_{M.D.ind}$

8.6 M.D. of capacitive reactive Power with export Active Power: $Q^{-}_{M.D.cap}$

8.7 M.D. of apparent Power with import Active Power: $S^{+}_{M.D.}$

8.8 M.D. of apparent Power with export Active Power: $S^{-}_{M.D.}$

9 Energy Values over the programmed integration period

9.1 Active Energy (import): $E^{+}_{a\,H}$

9.2 Output Active Energy: $E^{-}_{a\,H}$

9.3 Inductive reactive energy with import Active Power: $E^{+}_{r\,ind\,H}$

9.4 Capacitive reactive energy with import Active Power: $E^{+}_{r\,cap\,H}$

9.5 Inductive reactive energy with export Active Power: $E^{-}_{r\,ind\,H}$

9.6 Capacitive reactive Energy with export Active Power: $E^{-}_{r\,cap\,H}$

9.7 Apparent Energy with import Active Power: $E^{+}_{s\,H}$

9.8 Apparent Energy with export Active Power : $E^{-}_{s\,H}$

10 Time:

10.1 Life Timer t

8.3.2 Measurements Formulas:

Phase Voltages: U_{1N} $$U_{1N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}^2(n)}$$

where:

$U_{1N}(n)$ are the samples of the star voltages;

M is the number of samples on a period (64);

Star voltages THD $THD_{U_{1N}}$ in %

$$THD_{U_{1N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{1N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{1N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{1N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Line Current (coincident with the phase current): I_1 $$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}$$

$I_1(n)$ are the samples of the line currents.

Phase current THD: THD_{I_1}

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Active Power: P_1; $$P_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n)\, I_1(n)$$

Phase reactive Power: Q_1 $$Q_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n+M/4)\, I_1(n)$$

Phase apparent Power: S_1 $$S_1 = U_1 I_1$$

Phase Power Factor: λ_1 $$\lambda_1 = \frac{P_1}{S_1} sign(Q_1)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

Total Active Power: P_Σ $$P_\Sigma = P_1 * 3$$

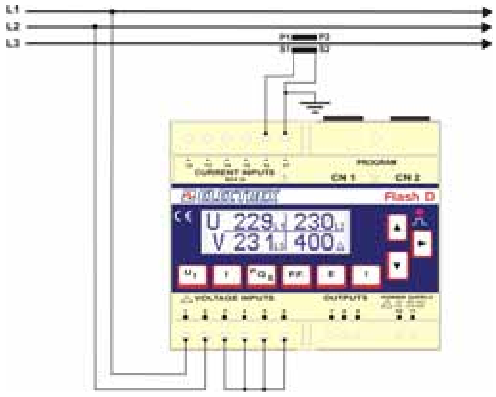
Total reactive Power: Q_Σ $$Q_\Sigma = Q_1 * 3$$

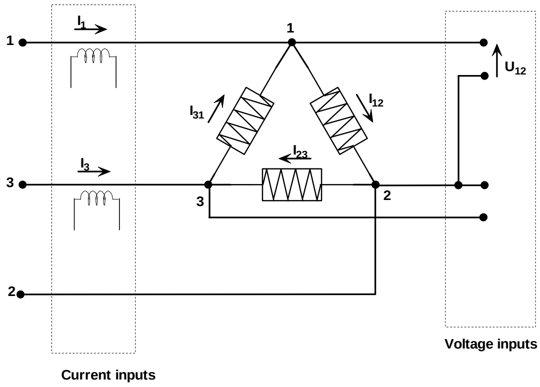
Total apparent Power: S_Σ $$S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$$

Total Power Factor: λ_Σ $$\lambda_\Sigma = \lambda_1$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.4 3P-b 3W Balanced three Phase without neutral 3 wires





8.4.1 Available Reading:

1 Frequency:

1.1 Voltage frequency V_{23}: f

2 RMS amplitude:

2.1 Phase-phase Voltages: U_{12}

2.2 Phase Current: I_3

3 Total harmonic distortion (in percentage):

3.1 Phase to phase Voltages THD: $THD_{U_{12}}$

3.2 Phase Current THD: THD_{I_3}

4 Power (on short period):

4.1 3 Phase Active Power: P_Σ

4.2 Total reactive Power: Q_Σ

4.3 Total apparent Power: S_Σ

5 Power Factor:

5.1 Total Power Factor: λ_Σ

6 Energies:

6.1 Active Energy (import): E_a^+

6.2 Active Energy (export): E_a^-

6.3 Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

6.4 Capacitive reactive Energy with import Active Power : $E_{r\,cap}^+$

6.5 Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

6.6 Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

6.7 Apparent Energy with import Active Power: E_s^+

6.8 Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period "Sliding Average",

7.1 Import average Active Power: P^{+}_{AVG}

7.2 Export average Active Power: P^{-}_{AVG}

7.3 Average inductive reactive Power with import Active Power: $Q^{+}_{AVG\,ind}$

7.4 Average capacitive reactive Power with import Active Power: $Q^{+}_{AVG\,cap}$

7.5 Average inductive reactive Power with export Active Power: $Q^{-}_{AVG\,ind}$

7.6 Average capacitive reactive Power with export Active Power: $Q^{-}_{AVG\,cap}$

7.7 Average apparent Power with import Active Power: S^{+}_{AVG}

7.8 Average apparent Power with export Active Power: S^{-}_{AVG}

8 Maximum demand:

8.1 M.D. of import Active Power: $P^{+}_{M.D.}$

8.2 M.D. of export Active Power: $P^{-}_{M.D.}$

8.3 M.D. of inductive reactive Power with import Active Power: $Q^{+}_{M.D.\,ind}$

8.4 M.D. of capacitive reactive Power with import Active Power: $Q^{+}_{M.D.\,cap}$

8.5 M.D. of inductive reactive Power with export Active Power: $Q^{-}_{M.D.\,ind}$

8.6 M.D. of capacitive reactive Power with export Active Power: $Q^{-}_{M.D.\,cap}$

8.7 M.D. of apparent Power with import Active Power: $S^{+}_{M.D.}$

8.8 M.D. of apparent Power with export Active Power: $S^{-}_{M.D.}$

9 Energy Values over the programmed integration period

9.1 Active Energy (import): $E^{+}_{a\,H}$

9.2 Output Active Energy: $E^{-}_{a\,H}$

9.3 Inductive reactive energy with import Active Power: $E^{+}_{r\,ind\,H}$

9.4 Capacitive reactive energy with import Active Power: $E^{+}_{r\,cap\,H}$

9.5 Inductive reactive energy with export Active Power: $E^{-}_{r\,ind\,H}$

9.6 Capacitive reactive Energy with export Active Power: $E^{-}_{r\,cap\,H}$

9.7 Apparent Energy with import Active Power: $E^{+}_{s\,H}$

9.8 Apparent Energy with export Active Power : $E^{-}_{s\,H}$

10 Time:

10.1 Life Timer t

8.4.2 Measurement Formulas:

Phase-phase Voltages: U_{12}

$$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{12}^2(n)}$$

Where: $U_{12}(n)$ are the samples of the chained values.
M is the number of sampling on a period (64)

Phase to phase Voltages THD $THD_{U_{23}}$ in %

$$THD_{U_{12}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{12}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{12}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{12}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Line Currents : I_3

$$I_3 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_3^2(n)}$$

$I_1(n)$ are the samples of the line currents.

THD of the phase currents: THD_{I_3}

$$THD_{I_3} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_3^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_3(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_3(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Three phase Active Power: P_Σ

$$P_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{23}(n + M/4)\, I_1(n)\right]\sqrt{3}$$

Three phase reactive Power: Q_Σ

$$Q_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{23}(n)\, I_1(n)\right]\sqrt{3}$$

Three phase apparent Power: S_Σ

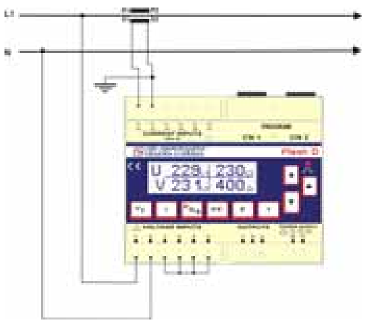
$$S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$$

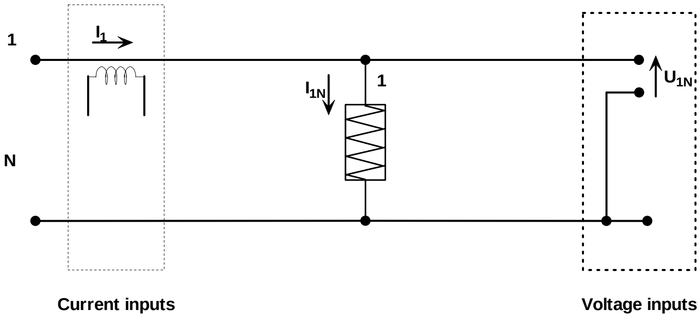
Three phase Power Factor: λ_Σ

$$\lambda_\Sigma = \frac{P_\Sigma}{S_\Sigma}\, sign(Q_\Sigma)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.5 1P (2W) Single phase





8.5.1 Available Reading:

1 Frequency:

1.1 Voltage Frequency V_{1N} : f

2 RMS Amplitude:

2.1 Voltage: U_{1N}

2.2 Phase Current: I_1

3 Total harmonic Distortion (in percentage):

3.1 Voltage THD: $THD_{U_{1N}}$

3.2 Phase Current THD: THD_{I_1}

4 Power (on short period):

4.1 Active Power: P_1

4.2 Reactive Power: Q_1

4.3 Apparent Power: S_1

5 Power Factor:

5.1 Power Factor : λ_1

6 Energies:

6.1 Active Energy (import): E_a^+

6.2 Active Energy (export): E_a^-

6.3 Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

6.4 Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

6.5 Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

6.6 Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

6.7 Apparent Energy with import Active Power: E_s^+

6.8 Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period “Sliding Average”,

7.1 Import average Active Power:	P_{AVG}^{+}
7.2 Export average Active Power:	P_{AVG}^{-}
7.3 Average inductive reactive Power with import Active Power:	$Q_{AVG\,ind}^{+}$
7.4 Average capacitive reactive Power with import Active Power:	$Q_{AVG\,cap}^{+}$
7.5 Average inductive reactive Power with export Active Power:	$Q_{AVG\,ind}^{-}$
7.6 Average capacitive reactive Power with export Active Power:	$Q_{AVG\,cap}^{-}$
7.7 Average apparent Power with import Active Power:	S_{AVG}^{+}
7.8 Average apparent Power with export Active Power:	S_{AVG}^{-}

8 Maximum Demand:

8.1 M.D. of import Active Power:	$P_{M.D.}^{+}$
8.2 M.D. of export Active Power:	$P_{M.D.}^{-}$
8.3 M.D. of inductive reactive Power with import Active Power:	$Q_{M.D.ind}^{+}$
8.4 M.D. of capacitive reactive Power with import Active Power:	$Q_{M.D.cap}^{+}$
8.5 M.D. of inductive reactive Power with export Active Power:	$Q_{M.D.ind}^{-}$
8.6 M.D. of capacitive reactive Power with export Active Power:	$Q_{M.D.cap}^{-}$
8.7 M.D. of apparent Power with import Active Power:	$S_{M.D.}^{+}$
8.8 M.D. of apparent Power with export Active Power:	$S_{M.D.}^{-}$

9 Energy Values over the programmed integration period

9.1 Active Energy (import):	$E_{a\,H}^{+}$
9.2 Output Active Energy:	$E_{a\,H}^{-}$
9.3 Inductive reactive energy with import Active Power:	$E_{r\,ind\,H}^{+}$
9.4 Capacitive reactive energy with import Active Power:	$E_{r\,cap\,H}^{+}$
9.5 Inductive reactive energy with export Active Power:	$E_{r\,ind\,H}^{-}$
9.6 Capacitive reactive Energy with export Active Power:	$E_{r\,cap\,H}^{-}$
9.7 Apparent Energy with import Active Power:	$E_{s\,H}^{+}$
9.8 Apparent Energy with export Active Power :	$E_{s\,H}^{-}$

10 Time:

10.1	Life Timer	t

8.5.2 Measurement Formulas:

Voltage: U_{1N}

$$U_{1N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}^2(n)}$$

$U_{1N}(n)$ are the samples of the star voltages;

M is the number of samples on a period (64);

Star voltages THD $THD_{U_{1N}}$ in %

$$THD_{U_{1N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{1N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{1N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{1N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Current: I_1

$$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}$$

Where: $I_1(n)$ are the samples of the line currents.

Phase current THD: THD_{I_1}

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Active Powers: P_1

$$P_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n)\, I_1(n)$$

Phase reactive Powers : Q_1

$$Q_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n + M/4)\, I_1(n)$$

Phase apparent Powers: S_1

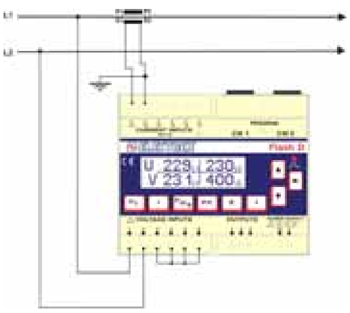
$$S_1 = U_1 I_1$$

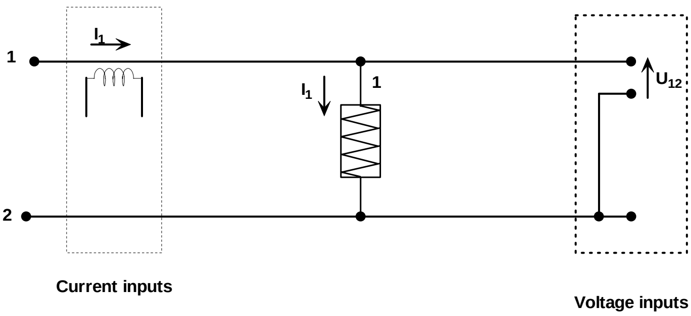
Phase Power Factors: λ_1

$$\lambda_1 = \frac{P_1}{S_1}\, sign(Q_1)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.6 2P (2W) Double phase





8.6.1 Available Reading:

1 Frequency:

1.1 Voltage frequency V_{12} : f

2 RMS amplitude:

2.1 Voltage: U_{12}

2.2 Phase Current: I_1

3 Total harmonic distortion (in percentage):

3.1 Voltage THD : $THD_{U_{12}}$

3.2 Phase Current THD: THD_{I_1}

4 Power (on short period):

4.1 Active Power: P_{Σ}

4.2 Reactive Power: Q_{Σ}

4.3 Apparent Power: S_{Σ}

5 Power Factor:

5.1 Power Factor: λ_{Σ}

6 Energies:

6.1 Active Energy (import): E_a^+

6.2 Active Energy (export): E_a^-

6.3 Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

6.4 Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

6.5 Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

6.6 Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

6.7 Apparent Energy with import Active Power: E_s^+

6.8 Apparent Energy with export Active Power: E_s^-

7 Average Power taken on a time interval (sliding window) of programmable amplitude:

7.1 Import average Active Power: P^{+}_{AVG}

7.2 Export average Active Power: P^{-}_{AVG}

7.3 Average inductive reactive Power with import Active Power: $Q^{+}_{AVG\,ind}$

7.4 Average capacitive reactive Power with import Active Power: $Q^{+}_{AVG\,cap}$

7.5 Average inductive reactive Power with export Active Power: $Q^{-}_{AVG\,ind}$

7.6 Average capacitive reactive Power with export Active Power: $Q^{-}_{AVG\,cap}$

7.7 Average apparent Power with import Active Power: S^{+}_{AVG}

7.8 Average apparent Power with export Active Power: S^{-}_{AVG}

8 Maximum Demand:

8.1 M.D. of import Active Power: $P^{+}_{M.D.}$

8.2 M.D. of export Active Power: $P^{-}_{M.D.}$

8.3 M.D. of inductive reactive Power with import Active Power: $Q^{+}_{M.D.\,ind}$

8.4 M.D. of capacitive reactive Power with import Active Power: $Q^{+}_{M.D.\,cap}$

8.5 M.D. of inductive reactive Power with export Active Power: $Q^{-}_{M.D.\,ind}$

8.6 M.D. of capacitive reactive Power with export Active Power: $Q^{-}_{M.D.\,cap}$

8.7 M.D. of apparent Power with import Active Power: $S^{+}_{M.D.}$

8.8 M.D. of apparent Power with export Active Power: $S^{-}_{M.D.}$

9 Energy Values over the programmed integration period

9.1 Active Energy (import): $E^{+}_{a\,H}$

9.2 Output Active Energy: $E^{-}_{a\,H}$

9.3 Inductive reactive energy with import Active Power: $E^{+}_{r\,ind\,H}$

9.4 Capacitive reactive energy with import Active Power: $E^{+}_{r\,cap\,H}$

9.5 Inductive reactive energy with export Active Power: $E^{-}_{r\,ind\,H}$

9.6 Capacitive reactive Energy with export Active Power: $E^{-}_{r\,cap\,H}$

9.7 Apparent Energy with import Active Power: $E^{+}_{s\,H}$

9.8 Apparent Energy with export Active Power : $E^{-}_{s\,H}$

10 Time:

10.1 Life Timer t

8.6.2 Measurements Formulas:

Voltage: U_{12}

$$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{12}^{2}(n)}$$

$U_{12}(n)$ are the samples of the star voltages;
M is the number of samples taken on a period (64);

Star voltage THD $THD_{U_{12}}$ in %

$$THD_{U_{12}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{12}^{2}(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{12}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^{2} + \left[\sum_{n=0}^{N-1} U_{12}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^{2}\right\}} - 1}$$

Phase Current: I_1

$$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^{2}(n)}$$

$I_1(n)$ are the samples of the line current.

Phase current THD: THD_{I_1}

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^{2}(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^{2} + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^{2}\right\}} - 1}$$

Active Power: P_Σ

$$P_\Sigma = \frac{1}{M}\sum_{n=0}^{M-1} U_{12}(n)\, I_1(n)$$

Reactive Power : Q_Σ

$$Q_\Sigma = \frac{1}{M}\sum_{n=0}^{M-1} U_{12}(n + M/4)\, I_1(n)$$

Phase apparent Power: S_Σ

$$S_\Sigma = U_{12} I_1$$

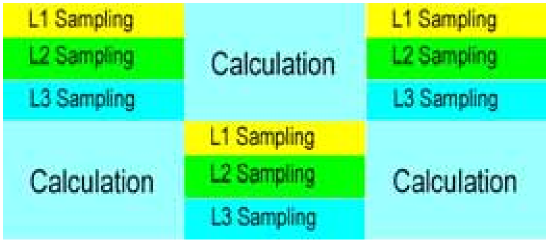
Phase Power Factor: λ_Σ

$$\lambda_\Sigma = \frac{P_1}{S_1} sign(Q_1)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.6.3 Sampling:

The signals to be measured are sampled with a sampling frequency f_c equal to 64 times the network frequency f : shortly, the number of samples per wave is fixed at 64 even with frequency variation.
The sampling is continuous on all waveform. Every 10 wave the samples are passed to the calculation part and the sampling restart for the next 10 waves.



8.6.4 Grid frequency Measurement:

The minimum measurable frequency is about 38 Hz.
The A/D converter is stopped out of the range 45 ÷ 65 Hz.
The frequency measurement is taken on phase L1 voltage.
The instrument can measure the fundamental frequency even in presence of very distorted waveforms and/or very low signal (few Volt).

8.7 Average values and energy Calculation.

8.7.1 Energy counting

FLASH D is equipped with 8 “non volatile” energy counters which can count up to a maximum of 99999999.9 kWh (either kvarh or kVAh) with a resolution equal to 0.1 kWh (either kvarh or kVAh). The value of these counters can be read either by communication port or display. When the highest value 99999999.9 is reached, the counting starts again from zero (roll-over).

8.7.2 Average Powers / maximum demand (m/Max)

FLASH D has a sliding window integrator which computes the average value of each of the 8 power measurements on an integration interval that is programmable in the range of 1 through 60 minutes in one minute steps.
The integration interval slides on the time axis in one minute intervals (when all the values of the measurements are updated). The settings of the integration intervals are not memorized when the instrument is turned off. While the duration of the integration interval may differ from the HOLD period, the two intervals are both aligned on the minute boundary. A command can be sent on the communication port to synchronize the HOLD period (and therefore of the minute boundary of the integration interval) with an external clock. The maximal value of each of the average power measurements is memorized in a non-volatile register (maximum demand, MD).
Both the average and maximum demand values are available through the display and the communication port. A command can be sent (either from the keyboard or the communication port) to reset the maximum demand values to zero. Another command resets the average power values: it resets the measurements taken during the last integration interval, but not the measurements taken in the last minute (the step with which the integration window slides). This preserves the synchronization of the integration interval and of the HOLD interval on the minute boundary.

8.7.3 HOLD function

The HOLD function in the Flash holds the energy counters and can be used to draw the load curves with data-logger devices or with appropriate consumption analysis software (Energy Brain). The energy counter values are sampled and memorized in registers, readable through the communication port. The sampling period programmable in the range of 1 through 60 minutes in one minute steps: the values are memorized at the beginning of the hold interval and are available through the end of the interval. At the beginning of the interval, the sampled values overwrite the old values: the hold period timer is reset when the instruments is turned on.

At the beginning of the hold period and in addition to the energy counter values, the instrument also memorizes:

- The actual duration – in seconds – of the last period (this may differ from the programmed value if sync commands have been sent);
- A 16 bit integer value, indicating the number of periods that have passed since the instrument was turned on (or since the last reset).

The time elapsed since the beginning of the current holding period can be read at any moment by accessing directly the hold timer.

8.7.4 Synchronization

The synchronization command terminates the current hold interval and begins a new one. The energy measurements taken in elapsed fraction are not accounted in the average power computations. When the hold interval is changed, an implicit synchronization is performed, thereby losing the contribution of the current interval to the average values. When the integration interval of the power averages is changed, all the maximum demand values and the average computations are reset, but not the measurements taken in the last minute (the step with which the integration window slides). This preserves the synchronization of the integration interval and of the HOLD interval on the minute boundary.

The integration interval can be changed either from the keyboard or the network, while the HOLD interval can only be changed from the network.

9 MODBUS Protocol

9.1 Foreword:

The instrument modbus protocol is implemented according to the document "*MODBUS Application Protocol Specification V1.1*", available in www.modbus.org .

The following "Public functions" are implemented:

- (0x01) Read Coils
- (0x02) Read Discrete Inputs
- (0x03) Read Holding Registers
- (0x04) Read Input Registers
- (0x05) Write Single Coil
- (0x06) Write Single Register
- (0x07) Read Exception Status
- (0x08) Diagnostics
- (0x0F) Write Multiple Coils
- (0x10) Write Multiple Registers
- (0x11) Report Slave ID

Regarding the "Diagnostics" function, the following "Sub-functions" are implemented:

- (0x0000) Return Query Data
- (0x0001) Restart Communications Option
- (0x0004) Force Listen Only Mode

The only implemented function "User Defined" is marked "Change Slave Address" (function code 0x42).

Through two coils named SWAP BYTES and SWAP WORDS, it is possible to modify the memory area organization where the modbus registers mapping are. The configuration [SWAP BYTES = FALSE, SWAP WORDS = FALSE] correspond to a "Big-Endian" type organization (Motorola like): the most significant data byte whose size is bigger than byte is allocated at the lower address.

The order of the bigger than byte data transmitted on the serial line depend on the memory organization.
In the "Big-Endian" organization type, the most significant byte is the one transmitted first (standard modbus).

Vice versa, the configuration [SWAP BYTES = TRUE, SWAP WORDS = TRUE] corresponds to an "INTEL like" memory organization (the most significant byte at the higher address, that is less significant byte transmitted first on the serial line).

Note: In the released version, not all the listed commands are available, check in the following pages for availability.

The default configuration is "Big-Endian" (Motorola like) as the modbus standard specify and not "Little-Endian" as the previous instruments.

9.2 “Device dependent” Functions

9.2.1 (0x11) Slave ID Report

(0x11) Report Slave ID			
Byte	***Description***		***Value***
0	address		
1	function code		0x11
2	byte count		0x1F
3	slave ID		
4	run indicator status		0xFF
5	Application version major		
6	Application version minor		
7	Loader version major		
8	Loader version minor		
9	Serial number	MSB	
10			
11			
12		LSB	
13	byte/word swap		○○○○ ○○○⊙ - **Swap bytes**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○○⊙○ - **Swap words**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○⊙○○ - **Swap doublewords**: 0 ≡ Standard; 1≡ Swapped ○○○○ ⊙○○○ - **Swap words in float values**: 0 ≡ Standard; 1≡ Swapped ⊙⊙⊙⊙ ○○○○ - **Not Allocated** (Must be set to 0)
14	tx delay (ms)	MSB	
15		LSB	
16	N coils	MSB	
17		LSB	
18	N discrete inputs (input status)	MSB	
19		LSB	
20	N holding registers	MSB	
21		LSB	
22	N input registers	MSB	
23		LSB	
24	CN1 option ID		0x00 = NONE 0x0C = 2 x 4-20 mA 0x0D = DONGLE 0x0E = RS485 0x0F = RS232 0xFF = ERROR
25	CN2 option ID		
26	Application checksum	MSB	
27			
28			
29		LSB	
30	Loader Checksum	MSB	
31			
32			
33		LSB	
34	CRC		
35			

9.2.2 (0x07) Exception Status Read

Not available.

9.3 “User defined” Functions

9.3.1 (0x42) Slave Address Change

The instruments accepts query with function code 0x42 (change slave address) only of “Broadcast” type (address 0). Consequently, there is no answer.

Change Slave Address Query			
Byte	***Description***		***Value***
0	Broadcast Address		0x00
1	Function Code		0x42
2	Serial Number	MSB	
3			
4			
5		LSB	
6	New Slave Address		
7	CRC		
8			

9.4 Register Mapping

9.4.1 Holding registers

Registers from address 0 to 7 are compatible with the registers of the old instrument, in order to assure the backwards compatibility. The one described are the ones of the KILO (T).
Registers from address 70 to 79 specific for FLASH D.
Registers from address 8 to 69 and from 132 to 139 are reserved for future expansions.

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
0	Integer Word	CT Ratio	1-9999 [A/A]	
1	Integer Word	VT Ratio	1-9999 [V/V]	
2	Integer Word	AVG Integration Time	1-60 [min]	
3		NOT USED		Return undefined valued, if read. Written values will be ignored.
4		NOT USED		Return undefined valued, if read. Written values will be ignored.
5		NOT USED		Return undefined valued, if read. Written values will be ignored.
6		NOT USED		Return undefined valued, if read. Written values will be ignored.
7	Integer Word	Digital Outputs Watchdog	0-65535 [min]	0 = Watchdog disabled
8 : 69		RESERVED		Return undefined valued, if read. Don’t write in this area.
70	Bitmapped Word	Words/Bytes swap flags	○○○○ ○○○⊙ ○○○○ ○○○⊙ **Swap bytes**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○○⊙○ ○○○○ ○○⊙○ **Swap words**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○⊙○○ ○○○○ ○⊙○○ **Swap doublewords**: 0 ≡ Standard; 1≡ Swapped ○○○○ ⊙○○○ ○○○○ ⊙○○○ **Swap words in float values**: 0 ≡ Standard; 1≡ Swapped ⊙⊙⊙⊙ ○○○○ ⊙⊙⊙⊙ ○○○○ **Not Allocated** (Must be set to 0)	Standard means Motorola like and Swapped means Intel like. The same bit combination must be written in both low and high part of register. In this manner the "byte swap" setting is meaningless for this register.
71	Integer Word	Tx delay time	0-100 [s/100]	

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
72	Bitmapped Word	Network type	○○○○ ○○○○ ○○○○ ○○○⊙ **Network type**: 0 ≡ 4 wires (Star); 1 ≡ 3 wires (Delta) ○○○○ ○○○○ ○○○○ ○○⊙○ **Import/Export**: 0 ≡ Export disabled (2 quadrants); 1 ≡ Export enabled (4 quadrants) ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙○○ **Not Allocated**	
73	Integer Word	CT Primary	1-10000 [A]	
74	Integer Word	CT Secondary	1 or 5 [A]	
75 76	Integer (4 bytes)	VT Primary	1-400000 [V]	
77	Integer Word	VT Secondary	1-999 [V]	
78	Integer Word	AVG/MD powers integration time	1-60 [min]	
79	Integer Word	Counters hold time	1-60 [min]	
80	Integer Word	Analog out 1 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	Accessing this register cause an exception response if 4-20mA option is not present.
81	Integer Word	Analog out 1 - Mode		Accessing this register cause an exception response if 4-20mA option is not present.
82 83	Float IEEE754	Analog out 1 - Scale begin value		Accessing this register cause an exception response if 4-20mA option is not present.
84 85	Float IEEE754	Analog out 1 - Scale end value		Accessing this register cause an exception response if 4-20mA option is not present.
86	Integer Word	Analog out 2 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	Accessing this register cause an exception response if 4-20mA option is not present.
87	Integer Word	Analog out 2 - Mode		Accessing this register cause an exception response if 4-20mA option is not present.
88 89	Float IEEE754	Analog out 2 - Scale begin value		Accessing this register cause an exception response if 4-20mA option is not present.
90 91	Float IEEE754	Analog out 2 - Scale end value		Accessing this register cause an exception response if 4-20mA option is not present.

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
92	Bitmapped Word	Digital out 1 - Configuration	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ - **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
93	Bitmapped Word	Digital out 2 - Configuration	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ - **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
94	Integer Word	Digital Outputs Watchdog	0-65535 [min]	0 = Watchdog disabled
95	Integer Word	Alarm 1 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	
96	Bitmapped Word	Alarm 1 - Mode	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Alarm coil driving mode**: 00 ≡ Normal 01 ≡ Pulsed 10 ≡ Not allowed 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ **Alarm type:** 0 ≡ Min; 1≡ Max ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
97	Float IEEE754	Alarm 1 - Threshold		
99	Integer Word	Alarm 1 - Histeresys	0-99 [%]	
100	Integer Word	Alarm 1 - Latency	1-99 [s]	
101	Integer Word	Alarm 2 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
102	Bitmapped Word	Alarm 2 - Mode	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Alarm coil driving mode**: 00 ≡ Normal 01 ≡ Pulsed 10 ≡ Not allowed 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ **Alarm type:** 0 ≡ Min; 1≡ Max ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
103	Float IEEE754	Alarm 2 - Threshold		
105	Integer Word	Alarm 2 - Histeresys	0-99 [%]	
106	Integer Word	Alarm 2 - Latency	1-99 [s]	
107 : 118		RESERVED		Return undefined valued, if read. Don’t write in this area.
119	Bitmapped Word	Network type (extended)	○○○○ ○○○○ ○○○○ ○⊙⊙⊙ **Network type**: 0-5 0 ≡ 1P 2W, 1 ≡ 2P 2W, 2 ≡ 3P 4W, 3 ≡ 3P_3W, 4 ≡ 3P-b 4W, 5 ≡ 3P-b 3W ○⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated** ⊙○○○ ○○○○ ○○○○ ○○○○ **Import/Export**: 0 ≡ Export disabled (2 quadrants); 1 ≡ Export enabled (4 quadrants)	
120	Bitmapped Word	Pulse Out 1 - Quantity selection	○○○○ ○○○⊙ ○○○○ ○○○○ **Measurement scaling**: 0=scaled to signal at primary side of CT/VT; 1=scaled to signal at secondary side of CT/VT; ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Measurement selection:** 0-7 0=P+, 1=P-, 2=Qind+, 3=Qcap+, 4=Qind-, 5=Qcap-, 6=S+, 7=S- ⊙⊙⊙⊙ ⊙⊙⊙○ ○○○○ ○○○○ **Not Allocated**	
121	Integer Word	Pulse Out 1 - Pulse weight / Pulse Duration	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Pulse Weight**: 0-7 (weight = 10^ (n-1) Wh) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Pulse Width**: 5-90 (mS * 10)	

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
122	Bitmapped Word	Pulse Out 2 - Quantity selection	○○○○ ○○○⊙ ○○○○ ○○○○ **Measurement scaling**: 0=scaled to signal at primary side of CT/VT; 1=scaled to signal at secondary side of CT/VT; ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Measurement selection:** 0-7 0=P+, 1=P-, 2=Qind+, 3=Qcap+, 4=Qind-, 5=Qcap-, 6=S+, 7=S- ⊙⊙⊙⊙ ⊙⊙⊙○ ○○○○ ○○○○ **Not Allocated**	
123	Integer Word	Pulse Out 2 - Pulse weight / Pulse Duration	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Pulse Weight**: 0-7 (weight = 10^ (n-1) Wh) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Pulse Width**: 5-90 (mS * 10)	
124 : 127	RESERVED		Return undefined valued, if read. Don’t write in this area.	RESERVED
128	Bitmapped Word	Digital out 1 - Configuration	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Tariff ○○○○ ○○○○ ○○○○ ○⊙○○ **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
129	Bitmapped Word	Digital out 2 - Configuration	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Tariff ○○○○ ○○○○ ○○○○ ○⊙○○ **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
130 .. 139		RESERVED		Return undefined valued, if read. Don’t write in this area.

9.4.2 Parameter selection tables

The following tables allow the selection of the parameters to be associated to the alarms and to analog outputs.
The Main index and the Sub index have to be specified in binary format (HEX).

All cells identified with are available only in Import/Export configuration.

3Ph-4W

Main Index \ Sub Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
1	×	U_{LN}	U_{LL}	×	×	U_{1N}	U_{2N}	U_{3N}	U_{12}	U_{23}	U_{31}	×	×	×	×	×	×	$U_{1N\div3N}$	$U_{12\div31}$
2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
3	×	×	×	I_N	I_Σ	I_1	I_2	I_3	×	×	×	×	×	×	×	×	×	$I_{1\div3}$	×
4	×	×	×	×	P_Σ	P_1	P_2	P_3	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
5	×	×	×	×	Q_Σ	Q_1	Q_2	Q_3	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
6	×	×	×	×	S_Σ	S_1	S_2	S_3	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
7	×	×	×	×	PF_Σ	PF_1	PF_2	PF_3	×	×	×	×	×	×	×	×	×	×	×
8	×	×	×	×	×	$THD_{U_{1N}}$	$THD_{U_{2N}}$	$THD_{U_{3N}}$	×	×	×	×	×	×	×	×	×	$THD_{U_{1N\div3N}}$	$THD_{U_{12\div31}}$
9	×	×	×	×	×	THD_{I_1}	THD_{I_2}	THD_{I_3}	×	×	×	×	×	×	×	×	×	$THD_{I_{1\div3}}$	×

3Ph-3W

Main Index \ Sub Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
1	×	×	U_{LL}	×	×	×	×	×	U_{12}	U_{23}	U_{31}	×	×	×	×	×	×	×	$U_{12\div31}$
2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
3	×	×	×	×	I_Σ	I_1	I_2	I_3	×	×	×	×	×	×	×	×	×	$I_{1\div3}$	×
4	×	×	×	×	P_Σ	×	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
5	×	×	×	×	Q_Σ	×	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
6	×	×	×	×	S_Σ	×	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
7	×	×	×	×	PF_Σ	×	×	×	×	×	×	×	×	×	×	×	×	×	×
8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	$THD_{U_{23}}$	$THD_{U_{31}}$	×	×	×	×	×	×	×	$THD_{U_{12\div31}}$
9	×	×	×	×	×	THD_{I_1}	THD_{I_2}	THD_{I_3}	×	×	×	×	×	×	×	×	×	$THD_{I_{1\div3}}$	×

3Ph-4W Balanced

Main Index \ Sub Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
1	×	×	×	×	×	U_{1N}	×	×	×	×	×	×	×	×	×	×	×	×	×
2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
3	×	×	×	×	×	I_1	×	×	×	×	×	×	×	×	×	×	×	×	×
4	×	×	×	×	P_Σ	P_1	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
5	×	×	×	×	Q_Σ	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
6	×	×	×	×	S_Σ	S_1	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
8	×	×	×	×	×	$THD_{U_{1N}}$	×	×	×	×	×	×	×	×	×	×	×	×	×
9	×	×	×	×	×	THD_{I_1}	×	×	×	×	×	×	×	×	×	×	×	×	×

3Ph-3W Balanced

Main Index \ Sub Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
1	×	×	×	×	×	×	×	×	U_{12}	×	×	×	×	×	×	×	×	×	×
2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
3	×	×	×	×	×	×	×	I_3	×	×	×	×	×	×	×	×	×	×	×
4	×	×	×	×	P_Σ	×	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
5	×	×	×	×	Q_Σ	×	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
6	×	×	×	×	S_Σ	×	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
7	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	×	×	×	×	×	×	×	×	×	×
9	×	×	×	×	×	×	×	THD_{I_3}	×	×	×	×	×	×	×	×	×	×	×

1Ph-2W																				
		Sub Index																		
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Main Index	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	×	×	×	×	U_{1N}	×	×	×	×	×	×	×	×	×	×	×	×	×
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	×	×	I_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	4	×	×	×	×	×	P_1	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	×	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	×	S_1	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	$THD_{U_{1N}}$	×	×	×	×	×	×	×	×	×	×	×	×	×
	9	×	×	×	×	×	THD_{I_1}	×	×	×	×	×	×	×	×	×	×	×	×	×

2Ph-2W																				
		Sub Index																		
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Main Index	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	×	×	×	×	×	×	×	U_{12}	×	×	×	×	×	×	×	×	×	×
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	×	×	I_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	4	×	×	×	×	×	P_1	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	×	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	×	S_1	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	×	×	×	×	×	×	×	×	×	×
	9	×	×	×	×	×	THD_{I_1}	×	×	×	×	×	×	×	×	×	×	×	×	×

9.4.3 Flas-D Input registers

In this chapter the FLASH D original registers are listed with all the available measurements.

Addr.	Type	Description	Unit	Symbol	System config / Notes
200 201	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{1N}}$ $THD_{U_{12}}$	⇒ **3P4W, 3P-b 4W, 1P2W** ⇒ **3P3W, 3P-b 3W, 2P2W**
202 203	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{2N}}$ $THD_{U_{23}}$	⇒ **3P4W** ⇒ **3P3W**
204 205	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{3N}}$ $THD_{U_{31}}$	⇒ **3P4W** ⇒ **3P3W**
206 207	Float IEEE754	Line current, THD	%	THD_{I_1}	⇒ **3P4W, 3P3W, 3P-b 4W, 1P2W**
208 209	Float IEEE754	Line current, THD	%	THD_{I_2}	⇒ **3P4W , 3P3W**
210 211	Float IEEE754	Line current, THD	%	THD_{I_3}	⇒ **3P4W , 3P3W, 3P-b 3W**
212 213	Float IEEE754	Voltage Input Frequency	Hz	f_{1N} f_{12}	⇒ **3P4W, 3P-b 4W, 1P2W** ⇒ **3P3W, 3P-b 3W, 2P2W**
214 215	Float IEEE754	Phase to Neutral Voltage, RMS Amplitude	V	U_{1N}	⇒ **3P4W, 3P-b 4W, 1P2W**
216 217	Float IEEE754	Phase to Neutral Voltage, RMS Amplitude	V	U_{2N}	⇒ **3P4W**
218 219	Float IEEE754	Phase to Neutral Voltage, RMS Amplitude	V	U_{3N}	⇒ **3P4W**
220 221	Float IEEE754	Phase to Phase Voltage, RMS Amplitude	V	U_{12}	⇒ **3P4W, 3P3W, 3P-b 3W, 2P2W**
222 223	Float IEEE754	Phase to Phase Voltage, RMS Amplitude	V	U_{23}	⇒ **3P4W, 3P3W**
224 225	Float IEEE754	Phase to Phase Voltage, RMS Amplitude	V	U_{31}	⇒ **3P4W, 3P3W**
226 227	Float IEEE754	Line current, RMS Amplitude	A	I_1	⇒ **3P4W, 3P3W, 3P-b 4W, 1P2W**
228 229	Float IEEE754	Line current, RMS Amplitude	A	I_2	⇒ **3P4W , 3P3W**
230 231	Float IEEE754	Line current, RMS Amplitude	A	I_3	⇒ **3P4W , 3P3W, 3P-b 3W**
232 233	Float IEEE754	Neutral Current, RMS Amplitude	A	I_N	⇒ **3P4W**
234 235	Float IEEE754	Phase Active Power (+/-)	W	P_1	⇒ **3P4W, 3P-b 4W, 1P2W**
236 237	Float IEEE754	Phase Active Power (+/-)	W	P_2	⇒ **3P4W**
238 239	Float IEEE754	Phase Active Power (+/-)	W	P_3	⇒ **3P4W**
240 241	Float IEEE754	Phase Reactive Power (+/-)	var	Q_1	⇒ **3P4W, 3P-b 4W, 1P2W**
242 243	Float IEEE754	Phase Reactive Power (+/-)	var	Q_2	⇒ **3P4W**

Addr.	Type	Description	Unit	Symbol	System config / Notes
244 245	Float IEEE754	Phase Reactive Power (+/-)	var	Q_3	⇒ **3P4W**
246 247	Float IEEE754	Phase Apparent Power	VA	S_1	⇒ **3P4W, 3P-b 4W, 1P2W**
248 249	Float IEEE754	Phase Apparent Power	VA	S_2	⇒ **3P4W**
250 251	Float IEEE754	Phase Apparent Power	VA	S_3	⇒ **3P4W**
252 253	Float IEEE754	Phase Power Factor (+/-)	-	λ_1	⇒ **3P4W, 3P-b 4W, 1P2W**
254 255	Float IEEE754	Phase Power Factor (+/-)	-	λ_2	⇒ **3P4W**
256 257	Float IEEE754	Phase Power Factor (+/-)	-	λ_3	⇒ **3P4W**
258 259	Float IEEE754	Phase Voltage, Mean THD	%	THD_{U_λ} THD_{U_Δ}	⇒ **3P4W** ⇒ **3P3W**
260 261	Float IEEE754	Line current, Mean THD	%	THD_{I_Σ}	⇒ **3P4W, 3P3W**
262 263	Float IEEE754	Phase to Neutral Mean Voltage, RMS Amplitude	V	U_λ	⇒ **3P4W**
264 265	Float IEEE754	Phase to Phase Mean Voltage, RMS Amplitude	V	U_Δ	⇒ **3P4W, 3P3W**
266 267	Float IEEE754	Three phase current, RMS Amplitude	A	I_Σ	⇒ **3P4W, 3P3W**
268 269	Float IEEE754	Total Active Power (+/-)	W	P_Σ	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
270 271	Float IEEE754	Total reactive power (+/-)	var	Q_Σ	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
272 273	Float IEEE754	Total apparent power	VA	S_Σ	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
274 275	Float IEEE754	Total power factor (+/-)	-	λ_Σ	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
276 277	Float IEEE754	Total imported Active Power, AVG	W	$P_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
278 279	Float IEEE754	Total imported inductive power, AVG	var	$Q_{m\ ind} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
280 281	Float IEEE754	Total imported capacitive power, AVG	var	$Q_{m\ cap} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
282 283	Float IEEE754	Total imported apparent power, AVG	VA	$S_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
284 285	Float IEEE754	Total exported Active Power, AVG	W	$P_m -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
286 287	Float IEEE754	Total exported inductive power, AVG	var	$Q_{m\ ind} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
288 289	Float IEEE754	Total exported capacitive power, AVG	var	$Q_{m\ cap} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
290 291	Float IEEE754	Total exported apparent power, AVG	VA	$S_m -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**

Addr.	Type	Description	Unit	Symbol	System config / Notes
292 293	Float IEEE754	Total imported Active Power, MD	W	$P_{Max}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
294 295	Float IEEE754	Total imported inductive power, MD	var	$Q_{Max\ ind}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
296 297	Float IEEE754	Total imported capacitive power, MD	var	$Q_{Max\ cap}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
298 299	Float IEEE754	Total imported apparent power, MD	VA	$S_{Max}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
300 301	Float IEEE754	Total exported Active Power, MD	W	$P_{Max}-$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
302 303	Float IEEE754	Total exported inductive power, MD	var	$Q_{Max\ ind}-$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
304 305	Float IEEE754	Total exported capacitive power, MD	var	$Q_{Max\ cap}-$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
306 307	Float IEEE754	Total exported apparent power, MD	VA	$S_{Max}-$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
308	Integer Word	Hold counters, in progress interval elapsed time	s		
309	Integer Word	Hold counters, last expired interval duration	s		
310	Integer Word	Hold counters, last expired interval ID			
311 312	Integer Double Word	Hold counter, imported active energy	kWh/10	$E_a +_H$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
313 314	Integer Double Word	Hold counter, imported inductive energy	kvarh/10	$E_{r\ ind} +_H$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
315 316	Integer Double Word	Hold counter, imported capacitive energy	kvarh/10	$E_{r\ cap}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
317 318	Integer Double Word	Hold counter, imported apparent energy	kVAh/10	$E_S +_H$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
319 320	Integer Double Word	Hold counter, exported active energy	kWh/10	$E_a -_H$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
321 322	Integer Double Word	Hold counter, exported inductive energy	kvarh/10	$E_{r\ ind} -_H$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
323 324	Integer Double Word	Hold counter, exported capacitive energy	kvarh/10	$E_{r\ cap} -_H$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
325 326	Integer Double Word	Hold counter, exported apparent energy	kVAh/10	$E_S -_H$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
327 328	Integer (4 bytes)	Imported active energy	kWh/10	E_a+	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**

Addr.	Type	Description	Unit	Symbol	System config / Notes
329 330	Integer (4 bytes)	Imported inductive energy	kvarh/10	$E_{r\ ind}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
331 332	Integer (4 bytes)	Imported capacitive energy	kvarh/10	$E_{r\ cap}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
333 334	Integer (4 bytes)	Imported apparent energy	kVAh/10	E_S+	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
335 336	Integer (4 bytes)	Exported active energy	kWh/10	E_a-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
337 338	Integer (4 bytes)	Exported inductive energy	kvarh/10	$E_{r\ ind}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
339 340	Integer (4 bytes)	Exported capacitive energy	kvarh/10	$E_{r\ cap}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
341 342	Integer (4 bytes)	Exported apparent energy	kVAh/10	E_S-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
343 344	Integer (4 bytes)	Life Timer	S	t	
345 346 347 348	Integer (8 bytes)	Imported active energy (Hi Resolution)	Wh/10	E_a+	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
349 350 351 352	Integer (8 bytes)	Imported inductive energy (Hi Resolution)	varh/10	$E_{r\ ind}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
353 354 355 356	Integer (8 bytes)	Imported capacitive energy (Hi Resolution)	varh/10	$E_{r\ cap}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
357 358 359 360	Integer (8 bytes)	Imported apparent energy (Hi Resolution)	VAh/10	E_S+	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
361 362 363 364	Integer (8 bytes)	Exported active energy (Hi Resolution)	Wh/10	E_a-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
365 366 367 368	Integer (8 bytes)	Exported inductive energy (Hi Resolution)	varh/10	$E_{r\ ind}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
369 370 371 372	Integer (8 bytes)	Exported capacitive energy (Hi Resolution)	varh/10	$E_{r\ cap}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
373 374 375 376	Integer (8 bytes)	Exported apparent energy (Hi Resolution)	VAh/10	E_S-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only

9.4.4 Input Registers (backward compatibility area)

In this area the registers guaranteeing the compatibility with the previous ELECTREX products are listed. This allows compatibility with written software. The considered registers are KILO (T)'s.

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
0 1	Float IEEE754	Three-phase voltage, RMS amplitude	V	U_{Δ}	⇒ **3P4W, 3P3W**
2 3	Float IEEE754	Three-phase current, RMS amplitude	A	I_{Σ}	⇒ **3P4W, 3P3W**
4 5	Float IEEE754	Total Active Power (+/-)	W	P_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
6 7	Float IEEE754	Total reactive power (+/-)	var	Q_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
8 9	Float IEEE754	Total apparent power	VA	S_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
10 11	Float IEEE754	Total power factor (+/-)	-	λ_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
12 13	Float IEEE754	Total imported Active Power, AVG	W	$P_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
14 15	Float IEEE754	Total imported apparent power, AVG	VA	$S_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
16 17	Float IEEE754	Total imported Active Power, MD	W	$P_{Max} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
18 19	Float IEEE754	Total imported apparent power, MD	VA	$S_{Max} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
20 21	Float IEEE754	Imported active energy	KWh	$E_a +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
22 23		NOT USED			Return undefined valued, if read.
24 25	Float IEEE754	Imported inductive energy	Kvarh	$E_{r\ ind} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
26 27	Integer (4 bytes)	Serial number		S/N	
28 29	Float IEEE754	Phase to neutral RMS Voltage	V	U_{1N}	⇒ **3P4W, 3P-b 4W, 1P2W**
		Phase to phase RMS Voltage		U_{12}	⇒ **3P3W, 3P-b 3W, 2P2W**
30 31	Float IEEE754	Phase to neutral RMS Voltage	V	U_{2N}	⇒ **3P4W**
		Phase to phase RMS Voltage		U_{23}	⇒ **3P3W**
32 33	Float IEEE754	Phase to neutral RMS Voltage	V	U_{3N}	⇒ **3P4W**
		Phase to phase RMS Voltage		U_{31}	⇒ **3P3W**
34 35	Float IEEE754	Line current, RMS amplitude	A	I_1	⇒ **3P4W, 3P3W, 3P-b 4W, 1P2W**
36 37	Float IEEE754	Line current, RMS amplitude	A	I_2	⇒ **3P4W , 3P3W**

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
38 39	Float IEEE754	Line current, RMS amplitude	A	I_3	⇒ **3P4W , 3P3W, 3P-b 3W**
40 41	Float IEEE754	Phase Active Power (+/-)	W	P_1	⇒ **3P4W, 3P-b 4W, 1P2W**
42 43	Float IEEE754	Phase Active Power (+/-)	W	P_2	⇒ **3P4W**
44 45	Float IEEE754	Phase Active Power (+/-)	W	P_3	⇒ **3P4W**
46 47	Float IEEE754	Voltage Input Frequency	Hz	f_{1N} f_{12}	⇒ **3P4W** ⇒ **3P3W**
48 49	Float IEEE754	Phase reactive power (+/-)	var	Q_1	⇒ **3P4W, 3P-b 4W, 1P2W**
50 51	Float IEEE754	Phase reactive power (+/-)	var	Q_2	⇒ **3P4W**
52 53	Float IEEE754	Phase reactive power (+/-)	var	Q_3	⇒ **3P4W**
54 55	Float IEEE754	Phase apparent power	VA	S_1	⇒ **3P4W, 3P-b 4W, 1P2W**
56 57	Float IEEE754	Phase apparent power	VA	S_2	⇒ **3P4W**
58 59	Float IEEE754	Phase apparent power	VA	S_3	⇒ **3P4W**
60 61	Float IEEE754	Phase reactive power (+/-)	var	Q_1	⇒ **3P4W, 3P-b 4W, 1P2W**
62 63	Float IEEE754	Phase reactive power (+/-)	var	Q_2	⇒ **3P4W**
64 65	Float IEEE754	Phase reactive power (+/-)	var	Q_3	⇒ **3P4W**
66 67	Float IEEE754	Phase power factor (+/-)	-	λ_1	⇒ **3P4W, 3P-b 4W, 1P2W**
68 69	Float IEEE754	Phase power factor (+/-)	-	λ_2	⇒ **3P4W**
70 71	Float IEEE754	Phase power factor (+/-)	-	λ_3	⇒ **3P4W**
72 73		NOT AVAILABLE			Return undefined valued, if read.
74 75	Float IEEE754	Exported active energy	kWh	$E_a -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
76 77		NOT USED			Return undefined valued, if read.
78 79	Float IEEE754	Exported capacitive energy	kvar	$E_{r\ cap} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
80 81	Float IEEE754	Exported inductive energy	kvar	$E_{r\ ind} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
82 83		NOT USED			Return undefined valued, if read.
84 85	Float IEEE754	Total imported capacitive energy	kvar	$E_{r\ cap}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
86 : 93		NOT AVAILABLE			Return undefined valued, if read.
94 95	Float IEEE754	Total imported inductive power, AVG	var	$Q_{m\ ind}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
96 : 125		NOT AVAILABLE			Return undefined valued, if read.
126 127	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{1N}}$ $THD_{U_{12}}$	⇒ **3P4W** ⇒ **3P3W**
128 129	Float IEEE754	Line current, THD	%	THD_{I_1}	⇒ **3P4W, 3P3W**
130 131	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{2N}}$ $THD_{U_{23}}$	⇒ **3P4W** ⇒ **3P3W**
132 133	Float IEEE754	Line current, THD	%	THD_{I_2}	⇒ **3P4W, 3P3W**
134 135	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{3N}}$ $THD_{U_{31}}$	⇒ **3P4W** ⇒ **3P3W**
136 137	Float IEEE754	Line current, THD	%	THD_{I_3}	⇒ **3P4W, 3P3W**
138 : 199		RESERVED			Return undefined valued, if read.

9.4.5 Coils (back compatibility)

Coils area compatible with the previous instruments:

Coils, back compatibility		
Address	*Description*	*Note:*
0	Clear AVG (1,3)	Reset all the power values in floating average
1	Clear AVG (1,3)	as 0001
2	Clear MD (1,3)	Reset all the power peak values
3	Clear MD (1,3)	as 0003
4	Clear energy counters (1)	Reset all the energy counters
5	Warm boot (1)	Reinitialize the instrument (does not reset the counters)
6	AVG/MD synchronization (1,3)	Synchronize the integration period
7	Clear MD (1,3)	as 0003
8	Not allocated	
9	Out 1 (3)	Controls output nr. 1 (if the alarm use is inhibited)
10	Out 2 (3)	Controls output nr. 2 (if the alarm use is inhibited)
11	Not allocated	
12	Digital outs watchdog enable (3)	Protection Timer on inputs in minutes
13	Not allocated	
14	Not allocated	
15	Not allocated	
16	Not allocated	
17	Swap words & bytes (2, 4)	Format Control of the memory stored data
18	Not allocated	

9.4.6 FLASH D coils

Proprietary FLASH D coils area.

FLASH D Coils		
Address	***Description***	***Note:***
64	Swap bytes (5)	Data format control in memory
65	Swap words (5)	Data format control in memory
66	Reset (warm boot) (1,2)	Reinitialize the device (does not reset the counters)
67	Clear energy counters (1,2)	Reset all the energy counters
68	Power integration synchronization (1,2)	Synchronize the integration time.
69	Clear AVG powers (1,2)	Reset all the power value in moving average
70	Clear MD powers (1,2)	Reset all the power peak values
71	NOT USED (1)	

(1) Reading the coil the result is always 1.
(2) The command is triggered on the leading edge, that is when the coil is set to 1 (TRUE). It is not necessary to set the coil to 0 after setting it to 1.
(4) Negative logic, to be compatible with Kilo:
Coil = 1 ⇨ Swap Bytes = Swap Words = FALSE (Motorola like, as Modbus standard)
Coil = 0 ⇨ Swap Bytes = Swap Words = TRUE (Intel like).
The measurement resets “Swap Bytes” flag status (negative).
(5) If set to 1 (TRUE), it inverts the bytes order (or word order) respect to the modbus standard (Motorola like).

10 Technical Characteristics

Measurement sections:

Voltmetric Inputs:

500 Vrms phase-phase (crest factor max 1.7);

Amperometric Inputs:

5 Arms (crest factor max 1.7);

Frequency: 45 ÷ 65 Hz Accuracy ± 0,1 Hz

Precision: Class 1 on active energy, compliant with CEI EN 61036;

Alternate Voltage Sensitivity, Range and Accuracy			
Nominal Range	Sensitivity[1]	Range	Accuracy[2]
500 V	400 mV	500 V	0.06 Range ± 0.35 Reading

- *Nota 1: Minimal Reading 20 V*
- *Nota 2: Guaranteed up to 50 V*

Alternate Current Sensitivity, Range and Accuracy			
Nominal Range	Sensitivity[1]	Range	Accuracy[2]
5 A	5 mA	6 A	0.06 Range ± 0.35 Reading
1 A	0.5 mA	1 A	0.06 Range ± 0.35 Reading

- *Note 1: Minimal reading 10 mA*
- *Note 2: Accuracy guaranteed up to 100 mA*

Overload:

Voltmetric Inputs: max 900 Vrms peak value for 1 second

Amperometric Inputs: max 100 Arms peak value for 1 s.

Maximum voltage to ground: for both voltage and current conductors the maximum voltage to ground is 350 Vrms.

Power Supply: separated power supply 85-265Vac/100-374Vdc or 24Vac/18-60Vdc depending on types. Maximum voltage to ground 265 Vrms

Power Consumption: 5 VA

Cabling: use category II cables.

Operating Temperature: from -20 to +60 °C

Relative Humidity (R.H.): max 95% without condensation

Applicable Regulations: Safety CEI EN 61010 class 2, category II, pollution class II. To be positioned in a protective electrical enclosure making the cabling not accessible.

Electromagnetic Compatibility: CEI EN 61326-1 A

Display: Backlit LCD with white LED lamp.

Automatic range adjustment: 2 current ranges

Offset: automatic amplifier offset adjustment

Counters: energy counters with 0.1 Wh resolution and maximum value 99,999,999.9 kWh.
Mount: 6 units Din Rail.
Weight: 360 g (460 g with packaging).
Protection: IP40 on front, IP20 elsewhere.
Size: 105 x 90 x 60 mm
Outputs: 2 digital outputs for pulses or alarms (Din 43864 27 Vdc 27 mA)

Options

Galvanically Isolated RS485

Output isolation 1000 Vrms

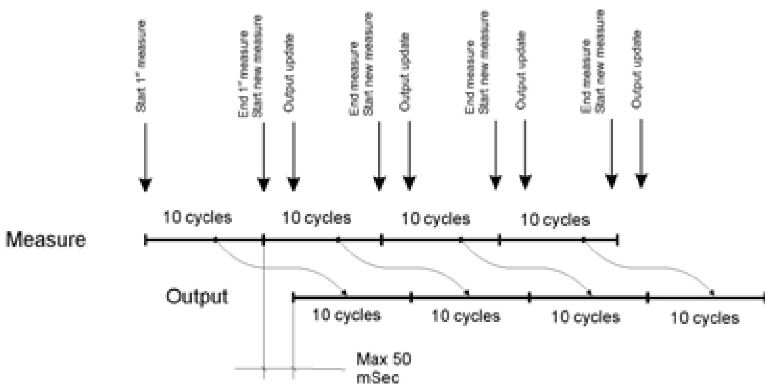
Galvanically Isolated RS232

Output isolation 1000 Vrms

Galvanically Isolated Analog Port 4-20 mA

Output isolation 1000 Vrms

Output: self supplied 0 to 20 mA on 500 Ohm max
Precision: < 0.2% Reading.
Stability: 200 ppm/°C
Latency: 50 ms maximum
Update frequency: 10 grid cycles frequency



11 Firmware Revisions

v1.11

- First release

12 Order codes

Instruments

Designator	Description	Code
Flash D ET	Three-phase energy analyzer **(Power supply 100/230 V)**	**PFE 430-00**
Flash D ET 24	Three-phase energy analyzer **(Power supply 24 V)**	**PFE 430-04**

Options

Designator	Description	Code
RS485 Interface (Din)	Interface with optoinsulated RS485 port.	**PFE 830-00**
RS232 Interface (Din)	Interface with optoinsulated RS232 port.	**PFE 825-00**
OUTPUT 2x 4-20 mA (Din	Double analogue output 4-20 or 0-20 mA programmable on any unit.	**PFE 835-00**

13 DECLARATION OF CONFORMITY

Electrex hereby declares that its range of products complies with the following directives

EMC 89/336/EEC   73/23CE   93/68 CE

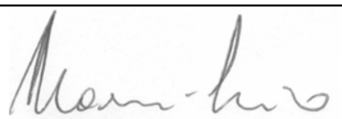
and complies with the following product's standard

CEI EN 61326 – IEC 61326   CEI EN 61010 – IEC 1010

The product has been tested in the typical wiring configuration and with peripherals conforming to the EMC directive and the LV directive.

ELECTREX S.r.l.   Via Claudia 96   41056 Savignano sul Panaro (MO) ITALY

November 2005
Erminio Mazzoni
Technical Director



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The document is subject to modification without prior notice.

the energy saving technology

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